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The Experiencing of Democracy and Progressive Education: A Constructivist Approach to Mathematics, A Workshop for Teachers

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Bank Street College & Progressive Education

Through the Lens of our Graduate Students

The Independent Study Collection

The Experiencing of Democracy and Progressive Education.

A Constructivist Approach to Mathematics.

A Workshop for Teachers.

by

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ABSTRACT.

The purpose of this paper is to develop a series of math workshops for Nursery and Kindergarten teachers in India. In these workshops the teachers will experience genuine problem solving, through group work based on social learning and cooperative education. It is my hope that these teachers will find joy and power through this process, and will begin their personal search on how to construct their own curriculum for progressive education, and thereby lead their students to experience learning developed around a democratic system.

I will chronicle the history of schooling and education in India, beginning with Vedic education [3000 B.C.] to Mohan Das Karam Chand Gandhi's educational vision for independent India. I will then discuss the development of the constructivist classroom, beginning with the educational philosophy of John Dewey. It is because of the way children construct their understanding of math in a constuctivist classroom, that I have chosen math as a way to illustrate this kind of learning. Children in a constructivist classroom are empowered to seek solutions, and develop strategies within the group, leading to an understanding and familiarity about how citizens function within a democratic society.

28th April 1997.

This paper is dedicated to ~

my two children
who gave up a bit of their childhood so that I could go to school...

to my husband who became twice the parent...

to my collegues and teachers of all ages,
who touched my life and changed it....

A grateful

thanks

to

Harriet, my advisor, for your affection,

time and the inspiration,

Victor and B.P., my Father-in-law and Uncle, for your insights into India, and hours spent,

Sanjiv, my husband for patiently bearing up all the days and nights I typed, and for all support, emotional and material.

And to

Esther

for your patience,

for your time,

your humor

and the effort you spent to hold my hand and hear me out.

~ CONTENTS ~

PART I :

INTRODUCTION

1
Introduction

How it all began:

I'll start with a story. I had just been appointed as an assistant teacher at the Roosevelt Island Day Nursery, in New York. I was to teach four year olds. I had just spent three years as a Nursery teacher in India. I felt comfortable and confident. Responding to the children's rich language and vitality, I began to introduce the alphabet to the children. The Head teacher, Jeanne, stopped me. She felt the children were not developmentally ready to fully make the transition to a level of symbolic thought.

'"Why?", I thought to myself. "These children seemed so mature. Yet some were only three +, younger than my students in India! Were these American children brighter, more intelligent?"

No, it wasn't that at all. It was just that the structure of their class room permitted them to be more vibrant, eloquent individuals, and their interaction with me was astoundingly rich. There was something about the invisible structure Jeanne's had created that I had to understand ~ WHAT? That's the answer I hope this presentation will give you.

VISION STATEMENT ~

As an N - five elementary teacher, in my native country India, I believed the goal of education was to produce productive individuals for society. I was also taught to believe that knowledge was the ultimate aspiration in education. From 1977, when I did my training to 1994, when I started my Masters in Elementary Education at The Bank Street College of Education, New York, I made it my personal quest to pass knowledge onto my students with as much enjoyment and hands on experience as I could. Later I came to regard the enhancing of my student's skills to be my primary concern, and I felt the knowledge that I wanted

to pass on to them would follow.

On being exposed to the progressive school of education, both as student and teacher, I have come to firmly believe that education dwells within the learner. A teacher's task is to guide the learning and create an environment where the learner learns to seek knowledge. However powerful and exciting knowledge is, it can also be a boundary, an end product. Now I believe the essence of education is the process of constructing knowledge.

More than merely honing our intellect, we also need to acquire the knowledge of how we can be productive contributors to the societies in which we live. We need to reflect constantly, question and evolve. We must take nothing for granted, but have the knowledge, confidence and autonomy, that is, the skill to look deeply within ourselves to experience the truth and make choices.

To be truly educated we need to be free. Freedom means to be free from the influences of others, and free to make one's own choice. To be free we need to be autonomous individuals. Autonomy is not egocentricity. Autonomy is to be able to act independently of external pressure, to be free. Freedom also means allowing others the same freedom we would expect for ourselves. An autonomous citizen is a responsible citizen who will contribute to, not be swayed by our society.

MISSION STATEMENT ~

For a democratic country its citizens must know how to **make choices** without being swayed by popular culture or being pressured by authority. To be productive citizens we need to **work cooperatively in a group**, contributing and negotiating toward our common goal. If we believe that these skills are imperative life skills, then we must allow our youngest citizens to learn and refine them from their childhood.

I genuinely believe education is beyond literacy. Education must also include an active socialization process that is experiential, tried, tested and learned actively

by our children, not handed down by a book of etiquette. *To be able to function within a group, and yet be autonomous should be an integral part of our lives, and therefore must be a prominent part of our educational curriculum.*

OPERATIONAL STRATEGY ~

I intend to use the teaching of mathematics as my message. To change our educational system I need to convince my colleagues that this very political belief can actually be translated into an educational reality. To implement my ideals I plan to do a series of workshops for teachers and expose them to the functioning of a constructivist classroom.

3.
RATIONALE

PART II:

PROGRESSIVE EDUCATION AND THE EXPERIENCING OF DEMOCRACY.

4
Introduction

India has a history that is more than 5000 years old. As a nation we are proud of our rich past and glory in our cultural heritage. Over these millennium we have produced original thought, a deeply evolved spiritualism, scientific and mathematical discoveries, magnificent art, music and literature. We are justifiably proud of our past achievements. Our present day contributions to the world of knowledge have also been significant. Yet it has been the exceptional, the selected few that have made these contributions. There is an enormous untapped, uneducated mass of our population that has never been able to participate in the intellectual pursuits our nation.

The turning point in the history of our nation came when we became a vibrant and viable democracy. Now every adult Indian has a voice in the direction our nation will take. The next chapter will give my reasons why we Indians with our young 50 year old democracy, need to broaden our educational

5

PROGRESSIVE EDUCATION AND THE EXPERIENCING OF DEMOCRACY

THE AIM:

My aim in writing this chapter is to put forward my newly evolving philosophy of education; so that I can gather all the scattered threads of ideas and knowledge I have gained, the experiences I have encountered and to weave them together with the history of education of my native country India. Is what I have experienced as a teacher in The Roosevelt Island Day Nursery and as a student at the Bank Street College of Education totally different from Indian education? Are they common threads that run through the patterns I see evolving? What could be my contribution to the fabric of Indian Education?

THE FORMAT:

The first chapter of my rationale will be divided into four parts ~

1 : The Historical Developments of Indian Education. It's influence on our 'national character' and contemporary Indian educational policy as also its aims.

2 : Mohan Das Karam Chand Gandhi's view of education as a means for restructuring Indian society.

3 : The similarity between the Progressive Philosophy of education, with special reference to John Dewey, and Mohan Das Karam Chand Gandhi's Educational policy.

4 : India's contemporary history. The changes that have taken place in our political spheres, and the need to review our educational policy in the view that we are now a " . . . DEMOCRATIC, SOCIALISTIC, SECULAR, REPUBLIC."

5 : Progressive Education and the Experiencing of Democracy.

6 :Lastly, my personal opinions and conclusions.

6.

HISTORICAL PERSPECTIVES OF INDIAN EDUCATION [1]

This paper addresses one component in our contemporary experience that is unique in our history. From 5,000 B.C. to 1947 our history has had waves of conquests and occupation alternated by golden ages of prosperity and growth. Except the British, [whose domination lasted 200 years] the conquering people stayed and ruled. We obeyed and molded ourselves the best we could. The leitmotifs that influenced education throughout Indian history continue to influence our contemporary attitude toward education.

The recorded history of the subcontinent starts before 5,000 B.C. With the hardening of the class system into the inflexible caste system, education became the domain of the *Brahmins* [the priestly caste] and along with religion remained the exclusive preserve of this tiny minority. Between 800 - 500 BC there was an uprising against this restricted club. Education was grudgingly opened to the *Kshatriyas* [the martial caste] and *Vaisyas* [the business and trading class]. *Buddha* [600 B.C.] rejected the caste system, the rituals, the ceremonies and the priestly elite. Buddhism opened education beyond Vedic[2] study and to the **common people** including women and young children. The quality of learning depended generally on the number of sutras [sayings of Buddha] that a student could master. [Valenti and Gutek, 1977]. The next upheaval in Indian Education took place around the advent of Islam in 1200 AD. Madrassas, the religious schools, were opened across the board for all Muslim males who wished to study. However, the emphasis remained on memorizing passages of the religious texts

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[1] [I was fortunate to find Jasper J. Valenti and Gerald L. Gutek 's Education and Society In India and Thailand in the Bank Street Library. All the facts and material , unless other wise mentioned, on the history of Indian education have been taken from there.]

[2] Four ancient social-religio-cultural texts that molded social thinking. The first Veda ,*the Rig Ved,* is believed to be the first 'book' of the world.

and the absolute authority of the teacher.

Throughout our history there was a great emphasis on education, memorizing and debating the ancient texts. The aims of education were both on an individual, spiritual and social level. On an individual level it was to attain *moksha* or *nirvana* [spiritual enlightenment and liberation from the cycles of rebirth]. On a social level it was to fulfill a social responsibility. As a contemporary Indian I cannot but help admire the aims of this practical education system, which produced exulted treaties of philosophy, statecraft, mathematics, language, literature and the arts. However, for the average student it was a rigid system demanding unquestionable obedience. For most of the country, education was closed. There was a system of apprenticeship from father to son. Caste, of course, determined one's whole education and life. [Valenti and Gutek, 1977]

At the time the British came to India in 1600, two separate educational systems existed in India: the Muslim and the Hindu schools. Both taught in languages which were not the commonly used vernacular. Both were conducted under religious auspices and sought to indoctrinate students in the tenets of their religions and both used rote learning as a method of teaching. In both streams education remained essentially a male preserve. Girls were expected to be homemakers and most were educated at home. Along with some basic literacy, they were taught the arts, dancing and music.

During the early years the East India Company made no attempt to Introduce western learning. The East India Company founded The Haileyburg College in 1806 to train civil servants to run their company. A great controversy arose between the Anglicits [3] and the Orientalists over the merits of Eastern or Western education and language. This controversy sparked the Indian Renaissance when

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[3][those that believed in the British philosophies]

the Indian Intellectuals were kindled by their exposure to western learning. Several Indians demanded the introduction of English and western education into India.

Raja Ram Mohan Roy and Ishwar Charan Vidya Sagar [early 19th century] were two of the better known Indian educators who spoke out for the opening of Indian Education. They attempted to revive Hinduism by amalgamating western learning especially in the fields of science. Both spoke out passionately for the education of women. [Valenti and Gutek, 1977]

Throughout the history of the British domination, whether as a company or as an Empire, the debate over India's educational policy continued. To their credit is the fact the British *had* an educational policy, but seemed to depend upon the attitudes of the Governor Generals and the current needs of the colonial rulers. The European education the imperial powers imposed on their colonial domains was *one that fitted the local people for subservience and servitude rather than self reliance*. There was a wide gap between the colonial system of education and the daily life of the common people [Gutek, 1991]. *Besides educated Indians continued to prefer literary education and neglected more practical subjects.* [Valenti and Gutek, 1977] The British in their customary tactic of divide and rule created an intellectual elite.

With the rise in national identity and a call for self rule Indians began to wrest a role for them selves in the governance of the country. By 1937 Indians began to have a more influential voice. Each province had an Education Minister. For the first time education policy included pre-primary age groups, adult literacy, social and recreational activities.

7.

GANDHI'S EDUCATIONAL VISION

In the period before independence in 1947, Gandhi developed a theory of education to aid his movement and to help in the reconstruction of India. It was a definite philosophy with clear goals and objectives, and a curriculum that he put into practice at the ashrams [small close communities, like a Kibbutz] that he established. It was in 1937 that Gandhi formulated his educational policy. For the education for freedom Gandhi believed that we needed to awaken a sense of cultural and national identity among the diverse Indian population. This could be done by studying the history, language, and literature indigenous to the country. He believed that studying one's own cultural heritage must not lead to a national chauvinism against other groups or nations. [Gutek, 1991]. Gandhi believed that children needed to be initially instructed in their own religion and language, yet he was a universalist and not a sectarian. I understand this to mean his respect for the individual and their differences, was as deep as his belief in social unity, but it had to be a unity of common purpose. The children learned the primary *tools* [italics mine] of reading, writing and arithmetic in addition to studying English, geography, history and singing.

Gandhi included vocational training as a part of basic education. Vocational education was designed to emphasize the dignity of work as well as to teach the individual employable skills. It was a purposeful learning.

In his Ashrams, manual labor, which included working with the land, taking pride and responsibilities to keep the area clean, spinning and practical crafts, became a deep philosophical statement. The individual performs small tasks, as part of a group for a much larger cause. The work requires discipline, hope [you may not see the end product immediately] and a certain lack of ego [but no lack of dignity!]. It is a contribution for the greater good of the community. Basic

education with its emphasis on an interactive and productive group would not only reenforce dignity of labor but also quell the modern tendency toward anti-social individualism.

Like pioneering educators, who strove to change the old order of education around the world, Gandhi viewed the traditional education as too verbal and passive. Gandhi's proposed educational programme was a means of liberating the child's creative impulse by providing him with an opportunity for free, spontaneous and purposeful activity. [Valenti & Gutek,1977] Gandhi believed in a holistic and harmonious development of the human being. He believed in using each of the children's senses " hands, feet, eyes, ears and nose as an intelligent use of the bodily organs provided the quickest way of developing intellect." [Valenti & Gutek,1977] He also believed in the education of the heart and a spiritual development.

Gandhi believed in the four fold education of the child - *physical, intellectual, emotional and social.* Learning was to begin with *objects commonly found in the child's environment*, be conducted in the child's mother tongue and be craft centered. Gandhi wished that all education should be productive and self supporting. The student would develop self confidence, pride in his or her craft and the dignity of labor, a fact which Gandhi felt was sadly lacking in our bookish urban education. Like his philosophy of *Ahimsa* or nonviolence, Gandhi 's educational philosophy evolved over the years. Gandhi's educational plan was an integral part of his design of a new society. He viewed education as a means of social reconstruction.

8.

GANDHI AND THE PROGRESSIVE EDUCATORS

Like John Dewey, Gandhi, also saw the school as a miniature society where children had rights and duties. Why did Gandhi center his curriculum around handicrafts? It does not seem practical nor vast enough for our urban school with their computer age classrooms. The spinning curriculum that Gandhi advocated was based on the same principles as 'the shops' at Caroline Pratt's City and Country School [Manhattan] and the farm camps of Manhattan Country School. Like educational reformers in Europe and America, Gandhi had in mind a curricular and instructional reform that would make schooling an interesting and challenging experience for children [Gutek,1991]

The underlying reasons why Gandhi chose *craft* as the center of his curriculum has the essence we still need to inculcate in our choice of curriculum for our children.

~ *Craft* is a concrete process, not an abstract intellectual exercise.

~ By using actual materials the children will be forced to solve problems, make choices and decisions with concrete objects that they can physically manipulate.

~The activities will be purposeful and meaningful.

~ Craft will make the lessons vital and interesting and free the schedule from boredom and routine.

~ Craft-centered education would have given the children a tangible end product and provide the children with a sense of accomplishment dignity and purpose.

~ Children would take pride in their work, develop self confidence and recognize the effort that working with ones hands entails and so come to appreciate the dignity of labor.

~ Craft and art are an aesthetic experience. Craft and design would link the fine and applied art and build a sense of aesthetics and an eye for detail.

Does contemporary India with her myriad problems have a cause charismatic and

important enough to inspire this self sacrifice? If we have won our freedom, do we have a cause at all? I believe we do. The preservation of our freedom and our fledgling 50 year old democracy can be enhances through restructuring our educational priorities.

9.
CONTEMPORARY INDIA AND EDUCATION.

WHITHER INDIAN EDUCATION? India became independent from the British on the 15th of August 1947. Ours is an agricultural and rural society with a rapidly expanding industrial, economic and technological horizons. Our nation in all its rich diversity dwells on several levels, from the most scientific and contemporary to the ancient and primitive. While we are advancing our nation into the 21st century, we are shaking some of our regions out of the feudal middle ages. How do we evolve an educational policy to suit every need?

There are several problems.

~ While our diversity is our greatest resource, it can also be a great barrier. For example we have two root languages and seventeen official languages in the country. Our three language educational policy while harmonious in theory, burdens the students.

~ As we have seen ours is a traditional society. Individual initiative gave way to the "*Way it has always been done*." Historically, learning, for the elite, was literary, verbal and by rote. Today our schools still tend to be bookish and evaluations rest upon the disgorging of prescribed materials. Whoever knows the modern day *sutra's* better is rewarded. We are moving further and further away from the Gandhian method. Our contemporary education system reflects a 5000 year old philosophy and history, with all its strengths, but also its weaknesses.

Never once in the history of our nation, till 1935 when the British *Sarkar* [4] gave us a chance to choose the members in the provincial assemblies [Valenti & Gutek,1977] did the common people influence our government. It was finally in 1950 when we adopted our constitution that India become a republic and a democracy. The main divergence from our historical past is that, while we still

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[4] Government

have the same languages, religions and ethnic groups, we now have the advantage of a geographical unity, an economic goal, and the ability to actively play a role in selecting our politicians. The difference is now we have unity and we have **choice**. We are a DEMOCRACY.

In India is democracy a political goal or a way of life? That is the dichotomy. Democracy is so new, and our traditional obedience so deep that even making choices needs to be learned. Upon glancing through Surendra K. Gupta's, *Citizen in the Making*, I found that his theory of citizenship and politics was a passive one. It dealt with the political arena not the individual citizen. His curriculum, "Political socialization" was based on the children's general knowledge and awareness of politicians and their political parties. He did not prepare the children to make choices or feel any responsibility toward their society. All the curriculum he dealt with seemed to be the traditional relationship with authority as well as a knowledge of the politics of that region. Democracy seemed to be an external factor not an internalized way of being.

How does one begin to see Democracy as more than a political statement, but experience it as a way of life?

10.

PROGRESSIVE EDUCATION & THE EXPERIENCING OF DEMOCRACY .

Despite their metaphysical difference's Gandhi and Dewey concurred that education should be a force to build socially integrated communities.

Dewey's philosophy of experimentalism in education was built upon the progressive era that was sweeping through America. It brought about a new way of looking at politics, law, art and education. Dewey's view of Democracy was a 'non-political' one. It was a way of life where every subject, custom or value was open to inquiry. The social setting was to be free of coercive and authoritarian persons so that the children could be free to inquire and experiment and take risks to solve their problems [Gutek,1991].

In Dewey's opinion, what was needed in education was to develop the instructional strategies to give learners the method and tactics to work together and resolve problems. The complete act of problem solving and thought is the most effective system for teaching and learning. Dewey had a profound impact on educators. Yet some rejected his ideas outright while others took certain key phrases ...'learning by doing....problem solving...children's interests and needs.' without accepting his whole philosophy.

Learning by doing has two implications. One way, the way we are familiar within India is essentially the Montessori[6] way, where the child experiences materials, touches them, manipulates them, but in an adult determined manner. In essence the children are doing what their care givers / adults have told them to do. This is

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[6]My Mother trained under Madam Montessori herself in just before independence in 1947. There are numerous Montessori schools in India.

passive 'doing'.

In the second way of learning by doing, essentially as in the Deweyian philosophy of progressive learning, the child determines how the experience goes. [Dewey, 1938] The children make choices, set their own goals, manipulate the materials as they wish, evaluate the result and more importantly are encouraged to 'revisit' the same activity as often and in as many ways as the children feel the need. As Evelyn Weber said, " Interest and effort lead to more potent learning." Knowledge and information are just one of the fundamentals of education. Children need to express their own ideas and interests only then can self activity be attained

Barring a few institutions, the method of education in India is what Dewey called **traditional education**.

In traditional education conformity becomes the criteria. Initiative, originality and independence are lost. When learning is external and not based on experience then what is handed down is taken as an absolute. These are then used as ends, as fixed points, instead of opening new doors, and becoming the launch pad for new experiences. [John Dewey, 1991]

Traditional schools do not take into account the diverse capacities, need, interests of the group. It is felt all human beings are so alike [in their learning styles] and therefore provides a uniform curriculum for all. It is imposition on the side of the teacher and [passive] reception and absorption on the side of the pupil [John Dewey, 1934].

Traditional schools fail to recognize that the initiative in growth comes from the power of the pupil. There can be no doubt that the mind of a child is not averse to learning, it does not have to be brow beaten and coaxed into action. Our job as educators is to find the materials and methods that will serve to evoke and direct a truly educative experience [John Dewey, 1934].

The course and curriculum are set, subject matter, and codes of conduct are all handed down from the authority [adults]. There is a value on conformity. [Dewey p.18]. The teacher sets the goals, and assesses the achievements. The focus of the classrooms are the adults. Rules are imposed from above and external to the child. [John Dewey, 1938]

Good teachers will try to disguise these impositions, we may repackage our methods into more palatable units, but the essence remains the same. The children are viewed as passive recipients of their ' cultural heritage.' The subject matter remains the study of facts, tightly bound with the past. [John Dewey, 1938]. Everything is given and there is one correct answer. Does this sound as if we are sowing the seeds of a democratic society?

I do not deny that children have learning "experiences" in the traditional system. However do these experiences give the students a chance to try things out for themselves? Do we foster an independence in their thirst to learn? Do we utilize the student's powers of judgement or do we expect them to echo our own? Do the problems / activities give the student's capacity to act independently ? What is the kind of experience we are really hoping for? We are looking for one that will arouse curiosity, strengthen initiative, set up desires and motivation for further thinking, exploration and learning. [John Dewey, 1938]

With all the importance given to teachers in traditional classrooms, what is the role of the teacher in a progressive classroom? Is the teacher merely a passive observer while the students take all the initiative and do all the learning? In the progressive schools the role of the teacher could not be more important. The teacher is a sensitive assessor, who prepares a curriculum to excite every child. Not all experiences are educative [John Dewey, 1938]. It is part of the teachers' role to select the experiences that will lead onto maximum growth. No longer dependent on text books the teacher needs to be intimately acquainted with the

community: physical, historical, economic, occupational in order to use the children's own world as an educational resource. Subject matter in the traditional schools follow a consecutive, orderly development along definite lines. Because the progressive school follows an interest without any fixed boundaries, this process requires more planning ahead by the teachers [John Dewey, 1934].

How do we open our classrooms so that they foster a democratic setup? I would put it down to choice, evaluation, social control and cooperative learning.

Choices or imagination vs. imitation ~ As Evelyn Webber states -the inner growth of the child will occur when children are allowed to make choices, however small, to adult perceptions. We need to give children the motive and the freedom for using materials in ways meaningful to them. This will encourage their observation, alertness of senses, invention and planning. The learners will be active in every part of the way. In selecting a problem to be solved or establishing a goal to be attained, determining the methods to reach at a solution, putting these into operation and evaluating the results [Evelyn Webber, 1984]. The children need to take personal responsibility for what they create and use their own judgement. Here Democracy is the democracy of being given the freedom to choose.

A class room that does not expect an absolute, perfect answer, that allows children free activity, what is termed *free play*, would allow the children to express their own interests and ideas. The children make their own selections and CHOICES. Be it problem solving in the block area or socialization in the dramatic play area, or the doll's-house as it was called in the school I taught in India, the child is given the initiative to solve problems. It is not the teachers' role to provide solutions. It therefore also frees the teacher from direct supervision of disciplining the class and hands part of the responsibility to the children. [Evelyn Webber, 1984].

In the traditional method, where text books, or even as far as work sheets are concerned there is only *one* correct answer. Have you noticed how often even in art and craft we limit the child to imitating the teacher's sample? The teacher relies upon a series of dictated directions. The children have no image themselves of what needs to be done. Instead of gaining power, the child is losing it by being made dependent on an external source. [Evelyn Webber, 1984]. If we teachers consider only our solution then where do the children get a chance to genuinely evaluate their work?

Which brings me to the second part :

Evaluations ~Dewey believed that individual growth and social progress were intertwined. [Evelyn Webber, 1984]. In the present traditional system in India, our children now work for grades, or to please the adults in their lives. How can they be truly democratic when they are constantly being externally evaluated? If children are encouraged to evaluate their own work, to work for inner satisfaction, not public praise, only then can the children be genuinely creative and honest. In the open classroom I witnessed in New York, I have seen all children constantly evaluate their work. They study their work, and they make changes in it. If we must say something, what we can remark upon is not what they have produced, [a beautiful painting or a bad spelling score], but the effort they have put into it. We can tell the child, "You really worked hard," or help the child with future strategies - "Maybe we could try and look for the meaning of the word in the passage." As Webber says, on page 102 of her book, 'The quantification of educational outcomes dominates our educational planning. Assessment need to be for the teacher to move forward not to judge as areas not covered. Quality of activity and consequences is more important.'

Social control or the social context for learning, is probably the most difficult part of the democratization of a class room. The teacher has to have the courage to relinquish absolute power and authority and become a partner. All teachers of

the progressive school will vouch for the effectiveness of this model! It is not easy but neither is dictatorial control! If children could experience the type of training that enables them to be self-directed, and critically evaluative from a very early age, effective social reform would follow.

The freedom to learn was never intended to result in anarchic behavior. The freeing was of the intellect to act purposefully to make effective choices. The teacher's role was to cultivate the child's learning through careful and deliberate exposure to opportunities for educational experiences -[that was the first aim of the **curriculum.**] [Evelyn Webber, 1984].

In fact, Dewey challenged the school of thought that recommended, "unrestrained freedom of action and speech... Responsibility to the social group clearly accompanied freedom."[Evelyn Webber, 1984]. In progressive classrooms children learn to do things not out of fear or even love for the teacher, but for the greater good of the group. It is the rules that they have discussed and realized work, and therefore even if it is hard for an egocentric child, in the end they know what they are working toward. In a classroom, social control would rest upon social necessity and a rational adjustment of any conflict. [Evelyn Webber,1984].

Does 'greater good of the group' sound like a moral science class?

In India we use text books and stories to teach the values of our culture to our children. We expose them to "Models of Good Behavior." Unless we give our children an open classroom where they can interact, where conflicts will arise, where they have the voice to express their opinions, how will they learn morality? We need to "have a process of value formation through experiencing democratic social relationships and through gaining increasing ability to understand and reconstruct our experiences. Our morality also needs to be related to the actual conditions in our lives. Sharing, cooperating, listening, waiting ones turn, ownership, courage of opinion, caring about other people's feelings, these are the conflicts we face in an open classroom and these are the values that will emerge from the group. If the framework of the class room is cooperation and

responsibility, then the activities of the class room have to reflect these aims"[Evelyn Webber, 1984].

Social awareness through cooperative learning:
Since the moral development of children is affected largely by cooperation, cooperative effort of various kinds should form an important phase of kindergarten procedure. The cooperation in question may be that of a small group or of all the children for some common end of real interest value [Evelyn Webber, 1984].

How does a teacher bring Democracy into the class room? - I understand cooperative learning to have some double connotations. One is to learn in a group by cooperating and helping each other. The other is to use the community within the class room as the subject matter. The implications of the former are obvious so I will concentrate on the latter.

The teacher must know how to bend and shape the given curriculum guides to represent the community within the class room. [Cuffaro, 1995] Community is unity, but not oneness. A community's diversities in its ethnic, economic, cultural and social differences, and within this diversity will lie the richness of the subject matter. The task of the teacher is to weave a fabric of shared meaning, aspirations and history. [Cuffaro, 1995].

John Dewey is quoted in Harriet Cuffaro's book *Experimenting with the World. John Dewey and the early childhood classroom.* [Teacher's College Press. NY]. as saying:'... [to understand]..The wider perspectives of other people's point of views is equivalent to the breaking down of those barriers of class, race, and natural territory which keep [people] from perceiving the full import of their activities. In a community as diverse as ours, a teacher does not have to pander

to or pussy foot around hurting the sentiments of another community if the curriculum of the class is honestly supportive of every individual. The teacher has to weigh activities that will foster a sense of solidarity. " What will help me create a social atmosphere and participation associated living? As I think of community, what space[and time] have I created for diverse voices, for interaction between and among various groups? What opportunity have I offered children for the experimentation, the novelty that will give rise to new visions, questions and the meaning that may challenge the unexamined, the stereotype in thought and feeling?"[Cuffaro, 1995]

Democracy is a way of life. Democracy is not the preserve of New Delhi or a capital city, It does not belong to the politicians, nor should it merely come alive on election day. Democracy is more than a political mechanism, it is a way of life, but a way of life that is not guaranteed to perpetuate itself automatically [Beydsterm, 1991].

Democracy is a personal way of life. It is a belief in the common person. Democracy means freedom. Not merely political but freedom to reach one's full potential. It means freedom from prejudice and intolerance and fear. For democracy to be functional we need full communication. Not just communication of knowledge and the media, but communication between all people. Intolerance and fear destroy the essential conditions of a democratic way of life. Our education not only has to have a multicultural flavor but it also needs to teach us to work in a group. Amicable cooperation does not preclude competition, rivalry or disagreement. Cooperation is giving differences a chance to show themselves, because everyone has a right to an opinion, and the greater opinions the more varied and rich the knowledge [Beydsterm, 1991].

11.

PERSONAL & CONCLUSION

Modern India is racing to keep up with the scientific world, and our education is top heavy and directed toward higher education. I agree our country needs this, but for us to become a truly democratic nation every person needs a chance to go to school.

I am not putting forward the humanistic angle to the politicians, captains of Industry and the bureaucrats. I am talking about a pure economic asset, a trained, skillful, adaptable, flexible, workforce. In my years in America almost every soap dish, toy, piece of clothing and machinery was made in China or Taiwan. Some clothes and sewage drain covers were all I ever saw that had MADE IN INDIA written on it. It made me so anguished. We have the second largest population in the world, a vibrant industry, why are we not feeding the markets? People tell me we can never "match" those world standards. We can and we will! If we educate our people, broaden their horizons, let them experience the need of exacting standards, we can flood the world markets. With an uneducated, ignorant, inward looking work force we can achieve nothing. Education, in the form of schooling, needs to become a force for nation building.

Where should the educational policy of our country aim? Our history speaks of an education by rote, of undisputed absolutes. Our way was always determined by an authority. The masses, [that's most of us] were never given a choice. And I mean in every aspect of our lives. From the prints and colors that our community wore, to the people we married, to the food we ate and who would ever question our rulers, they were *"mai-baap"**, [translated means literally our father and mother -the supreme care takers of our lives]. It has changed now. Democracy, is for the first time, a part of our national character. We are fortunate that Indians are very political. We are fortunate that millennia of training have taught us to

look toward the group. Now what we need are individuals who can make choices. Choices born of individual knowledge and experience, and hopefully, choices for the greater good of the group.

TOWARDS A CURRICULUM FOR DEMOCRACY

Under paid and unrecognized, we teachers in our lonely class rooms seem so powerless to shape this vast nation. But that is our greatest strength. We belong to no one but ourselves. And our power lies in the fact that from 5 - 25 years, however long our children get the opportunity to study, they are ours, not to mold, but to empower and educate. What we need is a cause and a voice. Our voices are not the giant roar of politicians but daily murmur of activists. Let us take pride in ourselves. We have something to teach beyond the text books. The way we teach, the methods we employ, is our message. We each have a value system. We must use it as our personal curriculum. We need to find a cause that spans everything and encompasses everyone. I have chosen freedom and democracy. We are the largest and youngest democracy, but we are an ancient people burdened by our fragmented and suppressive past. We need to free ourselves and progressive education is one of the vehicles by which we can.

PART III

A CASE FOR MATHEMATICS.

" I am a math phobic student who fell in love with the subject when I had to break it down and reconstruct my understanding of it to teach my students."

12
Introduction

Of all the subjects that I studied at The Bank Street of College of Education, it was the course on Math that moved me the most. For me as a student Math was a fearsome subject that dwelled in my text books, with an inflexible perfection demanded by my teachers. It was when I began to teach math and break it into morsels for my students to digest, that I began to see the beauty and logic of Math. When I experienced math in a constructivist classroom it became a fluid, flexible, creative medium of exploration. There is a physical and mental kaleidoscope of opportunities that have captivated my imagination and passion as a teacher.

Instead of being dependent on 'authority', the children were independent, autonomous problem solvers and seekers of knowledge They worked cooperatively with their peers, were able to transfer the experience of one medium [say unifix cubes] to another [pattern blocks], and even create their own algorithms without knowing they were doing so !

When I began to see children making connections that mirror the aspirations of adults in the job markets, I realized the vital importance of rethinking the way we traditionally viewed math.What are these qualities that Math and real life have in common ? That is the subject of my next chapter.

13.
Why I have chosen mathematics to be my vehicle to promote a progressive, autonomous, constructivist classroom?

In a world which functions more and more in bytes, finance and flow charts; where even human research is being converted to statistics; mathematics holds primacy. We can argue, in a world of calculators and computers, where do we need math? Yes the calculations are done, the procedures may be done, but to truly comprehend what those statistics are, and to be able to use and project them productively into our lives, we need to be *Mathematically literate* [Standards 1989]. More and more mathematical skills are seeping into the normal functioning of an urban professional. These are not merely the numerical skills of balancing a balance sheet, or compiling statistics. It is a mind set, catering to the open minded analytical skills that our technological world requires. We need to review our mathematical curriculum from nursery to college.

To convince parents and teachers that it is necessary to change our educational strategies and goals we need only look at the future employers of their children. The corporate and business houses are now looking for certain skills in their executives that go beyond academics.

> Information is the new capital, the new resource of out technological age. The person must know how to **independently seek** and access relevant information.

> With the rapid change in technology and the tendency for workers to change jobs, the employers will look for candidates who are flexible in their approach and life long learners. Adaptability is the key to change. The candidates must be able to **adapt** their knowledge and skills to the ever changing technology that research brings. There are fewer and fewer absolutes in our world.

> ***Problem solving*** is a key to the success of a manager. Managers need to understand the underlying features of a problem, to know how to cooperate with

others so that the organization is able to get the maximum input. Since most diverse problems are not well defined, the candidates need to know how to function **collaboratively** feeding off diverse information, opinions, experience and styles of functioning so that all aspects of the problem can be studied.

> Another talent that the employers are looking for is the ability to investigate and study data, see and **predict** trends and **patterns** that can be used to analyze information

> There is no doubt that markets are diverse. Diversity is more than new products and markets: diversity of experience, lifestyles, understanding, opinions become an economic necessity. To truly understand this diverse world, made quicker, but not smaller, by technology and communications, a competent, **diverse** mathematically literate workforce, is the need of the day.

> How can an organization hope to find a diverse workforce if there is no equitable distribution of mathematic skills? **Equitable** mathematical literacy has become an economic necessity.

Why is a mathematically literate workforce, white or blue collared, so important for industry? From the board room to the shop floor, technology and reasoning skills are the key to quality production. Equity has become an economic necessity. We cannot afford to have the majority of our workforce mathematically illiterate.

There has to be a reason why the far east is flooding world markets with electronic goods. Why? Is their work force more technically competent? I know their work force is leaps ahead of ours in India. There is a tendency to believe that our Indian work force cannot produce high fashion garments. An Italian firm, which I will not name, came to India to have their high fashion garments manufactured. They trained their 'illiterate workforce' and very graphically taught them to see how a quarter of an inch difference in the sewing of a seam can alter the fit of the garment. Once the workers understood this, they were able to produce garments matching the standards of those produced in Europe.

> When faced with relevant and irrelevant information, conflicting opinions and options, an individual needs to be able to sift fact from opinion, critically examine issues, verify facts and then mesh interrelated issues to form their opinions. They need to be fully confident, self critical and **autonomous** to do so. They must be able to take risks, self correct as they go along, and always, always, be flexible in their approach.

> And lastly, taking into account the capacities of their audience, the candidates must be able to **communicate** their thinking to others in clear lucid terms.

Do I think the only reason to teach constructivist maths is to link it to employment and productivity? No. It is only one of the reasons. There is more to the teaching of math than meets the eye. There is a whole hidden curriculum that the constructivist, progressive classroom brings to the learning of math. Along with other cognitive and life skills, my belief is a progressive, autonomous, constructivist classroom also enhances the very traits the future employers of our students seek, and sets the stage for living in an ideal Democratic community.

PART IV:

A CASE FOR A CONSTRUCTIVIST CLASSROOM

14
Introduction

To be able to facilitate a student [and future citizen] who is an autonomous, responsible problem solver willing to take risks, we need to give the initiative of learning to the child. This dichotomy of a young child selecting learning can only be understood when we believe that knowledge is not the be all and end all, but intangible skills like observation, analysis, creativity, initiative, cooperation are what we really wish a child to acquire.

What is the environment that can create such an atmosphere of learning ?

THE CONSTRUCTIVIST CLASSROOMS.

15

WHAT IS A CONSTRUCTIVIST CURRICULUM?

Mathematics needs to be experienced. A successful teacher will so structure the classroom so that children are free to experience and therefore construct their own mathematical concepts [Clements and Battista, 1990]. Yes, they do reinvent the wheel!

Yet it becomes their wheel. They know how to use it independently. If a system, as in traditional mathematical teaching, demands a single method and a single answer, then learners will view mathematics as a set of procedures to be mimicked, a dead language like Latin, as opposed to a living, breathing, lovable, sense-making activity.

How does this all come together? Learning is a social process [Clements and Battista, 1990], if we choose to enliven it so. A constructivist classroom is one where everyone in the class is involved in discovering, inventing, explaining, negotiating, sharing and evaluating [Clements and Battista, 1990].

To explain the functioning of a constructivist classroom let us compare some aspects of teaching math with those of a traditional classroom [Handout # three]. This chart is given over leaf:

Task	Traditional method	Constructivist method
Method of working	Text books and work sheets. Present two dimensional pictures, or examples, followed by abstract symbolic representations. The children memorize and regurgitate their responses.	Actively manipulate concrete objects. Relationships are discovered and become firm concepts for wider application later on.
Aim	To practice and perfect solving algorithms. The working of a problem can be done mechanically, checking answers at the back of the book. There is one way and one answer.	Children need: > to be autonomous and self motivated in their mathematical ability. > to discuss, reflect and make sense of the mathematical tasks and, therefore procedures. >to feel responsible for making sense and communicating their mathematical reasoning, as opposed to merely completing a mathematical assignment. [Cements and Battista, 1990].
How	Learning is done alone, usually with paper pencil and perhaps a calculator. The work is mainly oral or written.	Learning takes place in a material and social environment. Children work in groups. Work is manipulative, oral and written.
Problem solving.	Once the algorithms have been mastered, the students are given word problems as a form of mastering the skill taught.	Problems are given first. They are open ended with several methods to get to the answer. Children solve these concrete problem and discover the computation skills for them selves.
Teaching and Assess-ments	The teacher's role is to make the text book and prescribed syllabus as palatable as possible. A few students may be asked to discuss and demonstrate the computations on the board. The teacher then corrects the work/ papers. There is no immediate feedback as corrections take time, and children may not be able to correct their errors in understanding the problem or clarify difficulties immediately.	> A teacher is not merely an asker or an answerer of questions, but a partner in the learning process. Every student is also a teacher and learner in this shared process. >The adult's task is to constantly assess the children, not for the right answer, but their method of working, their developmental level and depth of understanding. >To provide them with appropriate tasks and materials with which children can construct, revise and find meaning through their own experience.

Now that we know some of the differences between the traditional and constructivist mathematical classrooms, let us discuss some of the unique features of the constructivist approach.

A constuctivist approach to mathematics is synonymous with autonomy. For the students to be truly creative, they must be self sufficient in thought and action. This does not mean that they should be free to do as they please. Autonomy presupposes responsibility. Autonomy without responsibility is anarchy!

There are important prerequisite in a constructivist classroom:

> The structure of the classroom.

>The role of the teachers and students.

> The materials used.

16

THE STRUCTURE OF THE CLASSROOM

As we use the term whole language, we now need to think in terms of whole mathematics. Mathematics needs to be useful and apparent. The children need to understand the reasons why they are learning math. Attendance charts, work time choices, calendar, time tables, cooking recipes, graphs, measurements, mathematical terms and even stories, should all be part of out lives and should be used daily. Also the class should be so arranged that children are able to independently to follow through an idea that may strike them without waiting for the teacher's assistance. Pencil, paper, scissors, manipulatives, trays, should be placed in a clear, well defined, easily accessible area. Having a math center is very conducive to spontaneous math activity. Along with this, there should be a time clearly demarcated for mathematical activities so that children who are not independently motivated have a time when they do, do mathematics. The tasks should be so arranged that children have a choice of activities, and they do not feel compelled to undertake an activity that does not interest them. Providing motivation and autonomy are the tasks of the teacher as much as providing a safe structure to experience mathematics.

17

THE ROLE OF THE TEACHERS AND STUDENTS

In the constructivst method the teacher's role becomes more subtle and difficult. The teacher's focus on the children's thinking rather than on their writing the correct answers. [Kamii and DeCkark, 1985]. Traditionally mathematics was based on absorption by the pupils and instruction by the teacher. In the constructivist approach the teacher's job is to assess the level of learning and not be concerned with the correctness of the answers but the process used by the children to arrive at the answer they did. Here, truly, the means is more important than the end. Our task is to constantly assess the learning of the children and provide them with tasks and materials with which children can construct, revise and find meaning through his or her own experience. One warning, the teacher has to be a *genuine partner in the pupil's search for the right answer.*

How does a teacher prevent a constructivist classroom from disintegrating into chaos, into an undirected free-for-all-discovery?

Constructivism is very much dependent on the guidance of the teacher and the structure that is brought to the classroom. How does one conduct a constructivst class? By having faith in the children's ability to learn, by being patient, and by being able to guide the students along their own path of discovery through questions. The teacher will need to structure the social and intellectual climate of the classroom so that the students have a stake, an ownership to the task set before them.

Why must we let the children be autonomous and self motivated in their mathematical ability?

Only with faith in their own abilities will the students feel motivated to freely discuss, reflect and make sense of the mathematical tasks and procedures. The students must feel responsible for making sense and communicating their mathematical reasoning, as opposed to merely completing a mathematical assignment. [Clements and Battista,

1990]. *The teacher must be very careful not to express an opinion of right or wrong.* If the teacher was to judge the correctness of the answer, the children would come to depend on the adult for the solution. If no one in a class can get the right answer, the teacher will know that the problem was too difficult for the class [Kamii, Lewis and Livingston, 1993]

During their preschool years, children view adults as all good or all bad. Parents and teachers are usually all good. When an adult gives a child an age **in**appropriate task, a task the child is literally not developmentally ready for, "'the child is not aware of that fact. She thinks, '*This teacher is all-wise and all-knowing and says I must learn this. But I can't: I don't understand. It must be me. I must be dumb . . .* ' Young children not only put their trust but also their sense of competence in our hands."[Elkind, 1994]. In these years, critical to a child's image of self worth and autonomy, we must tread very gently.

So how do, do teachers teach developmentally appropriate mathematics?
> By giving children the opportunity for focusing on working out mathematical relationships.
> By open-ended games where children are allowed to deal with actual palpable numbers.
> By giving the children genuine open-ended problems. If the children are developmentally ready, if they can see logico-mathematical relationships, then they will learn the function of mathematic symbols on their own [Kamii & De Clark, 1985].
And how do they manage to coordinate, monitor and give feedback to each child? How do teachers take the focus from themselves and give the children the autonomy to seek out their own solutions?
They use the finest resources at their disposal - their students.

Research done by both Vygotsky and Piaget as well as Perret-Clermont [1980] and Doise and Mugny [1984] found that when children were given a chance to agree,

disagree and convince each other, they demonstrated a higher level of thinking than children who did not have this opportunity. While children cannot learn logico-mathematical thinking from other people, genuine arguments can cause children to reexamine their thinking and construct a higher level of thinking from within.

In the constructivist approach there are a variety of problems that can be given to the children to solve. The one thing, however, that a teacher has to keep in mind is that the problems are open ended. This does not necessarily only mean that there are several acceptable answers, but that there are also several methods to arrive at the answer. Problems that the children can identify with and can solve concretely give the children a chance to solve it and discover computation skills for themselves without even knowing they are doing so.

An important tool in the repertoire of a constructivist teacher is cooperative learning. A teacher can divide a class into groups and give the groups the problem to solve. Each member of the group has a task or a contribution to make. The children work independently of the teacher only asking questions when none in the group has the answer. When the group has solved the problem the teacher asks each group to present how they solved the problem. The rest of the class questions them on their solution or clarify their doubts. [Kammi & De Clark, 1985]. In this method there is immediate feedback and the children can use 'a more competent other' to raise their level of learning.

Group games ~ Group games are an excellent choice because the children play them to please themselves rather than the teachers. The children monitor the answers, and disagreements can be a healthy form for discussion [Kamii & De Clark, 1985]. Additionally, group games contribute to children's social and moral development. Of course, again, one has to ensure the games are developmentally appropriate.

A case for Manipulatives - When children work with manipulatives they are constantly assimilating and accommodating and picking up concepts like empty and full, length thickness, etc. What they are doing is practicing and seeking out reversibility and other "action oriented words" [Vaidya, 1991]. If the teacher tries to get the students, while using manipulatives, to reach a particular answer, THE answer, the children will sense it and they will not risk taking mathematical initiatives [Clements and Battista, 1990]. The strength in using manipulatives also lies in the fact that children tend to think at the concrete observational level, so they are keenly attentive to perceptual clues - **physiognomic perceptions**.

At this stage of development children also tend to 'feel what they see' [Elkind, 1994] That is why many of their manipulative tasks have an emotional, dramatic play flavor to them. We adults have to be careful not to dismiss this as unimportant learning. If children are engaged, they are learning!

Children and numbers ~One of the traditional goals of mathematics is to teach numbers. From the earliest time children are encouraged to 'count'. As far as numbers go, the children do not have a unit sense of numbers until they reach the concrete-operational stage of development. They can use **nominal numbers**, where they name each number, but do not associate the number name with the number's value, [Clements and Battista, 1990]. They are able to grasp **ordinal numbers**, and follow the ranking of numbers. It is only later that they get a **unit** concept of numbers when they realize a number has a value and it is different from the other numbers. It is only when children can coordinate same and different that they can arrive at the notion of unit quantities [Elkind, 1994].

What are the stages in children's construction of numbers from nominal to unit concepts ~At first the child will count randomly. The child will skip and recount other objects. There is no logical relationship at this early stage in the child's cognitive development, between the number names or the quantity. In fact, at this stage, 1. 2. 3.

4.. are merely a series of names, very much like Monday Tuesday . . . are the days in a week [Kamii & De Clark, 1985].

Since, according to Piaget, the children are actively engaged in constructing their knowledge of the environment, we might as well use this genetically coded resource and help children construct their sense of numbers. A teacher may present 4 = ✂✂✂✂ in innumerable ways to the children, but it is only when the children have manipulated materials, compared the four objects with other quantities, contrasted 4 objects with 2 or 6, that the children create their own understanding of what 4 is. How is this done? Truly engaged children will reflect upon their concrete and mental actions, then integrate them into their existing structures of knowledge [Clements and Battista, 1990]

18

What could be our goals for a Constructivist Classroom?

1> **Independence** of function: In a constructivist classroom the children know exactly how to operate independently. There are procedures and boundaries so that they can concentrate on the tasks ahead. They know where to get what they need and how to ask for help when they need reenforcement.

2> **Adaptability:** The children are encouraged to revisit and explore materials and problems. They work independently and with others, learning early on that there are numerous ways to do a task.

3> **Problem solving:** When we give a problem to the class we teachers have to take care of two inputs.

The children feel confident to take risks and are not discouraged by their mistakes. In fact they should view their 'errors' as positive learning experiences.

The problems are genuine problems, which means they should have either several answers or several means of getting to the answers. There need be no time limit, and the children should be able to explore the possibilities till the children feel they are ready to share it with the class.

4> **See and predict patterns:** Starting from pattern blocks and unifix cubes children are exposed to patterns in the classroom. Seasons are a pattern, so are the days of the weeks, music is a pattern of notes, algorithms are also a pattern, a way of responding to certain problems. If the answers we seek are inflexible and absolute, then children will not be able to discover the flow or pattern of events. After all the atom is the pattern of the universe or visa- versa.

5> **Collaborative learning:** Vygotsky believed in collaborative learning and he brought us the term ZPD - Zone of Proximal Development. When children learn together in a group they are able not only to learn from 'more competent others' but from equally as competent others. By using each other as sounding boards, and challenging each other's assumptions, the children are able to learn not only to

respect another point of view, but broaden their own base of knowledge.

6> **Diversity:** The more inputs there are the richer the criterion there is for solving a problem. The deeper the understanding and the less the chance of having left something out. To be able to work with individuals with diverse inputs and see the pattern is to be able to get to the crux of a problem and its solution. However diversity in math goes beyond opinion. It is a mind set. If the children cannot get a solution, they need to be encouraged to think of other ways of approaching the problem. Diversity of opinions, of methods, of materials, of types of problems is the core to flexibility in math.

7> **Equitable Mathematical literacy:** I believe so strongly in equity in education that I plan to devoted an entire future workshop to it. Children have different abilities and styles of learning math. It is up to us teachers to diagnose these differences and to make our classes equitable so that all children have an equal chance at mathematical competence.

8> **Autonomous, self confident and critical students:** The fear of having to get *the correct answer* in traditional math classes can wipe out these three very desirable traits. In the age of calculators the answer is not the focus, the method is. I do not for a moment believe that children must not strive and practice to reach a correct solution, calculators are merely a time saving tool. However if reaching the correct solution hampers their creativity then it must take second place in the paradigm of mathematics. Students must be able to choose appropriate procedures, find answers and judge the validity of those answers. The students need to take the responsibility for their calculations and must first be fully satisfied with their own work before presenting it to others.

A very important part of an autonomous classroom is that the peer group and not the teacher be the source of knowledge. When students are convinced that the teacher has all the solutions they will not be motivated to search for the answers themselves.

9> **Communication skills:** Once the children have reached a consensus, then they have to present their solution to the class. This meta-mathematics, thinking about math, encourages children to think deeply about how they arrived at a solution. It

helps them clarify their own ideas. It helps them break down their thinking into presentable units like graphs or diagrams. They also have to learn to be skillful enough to defend their own ideas as well as think of how they can phrase questions to clear their difficulties. Rethinking, rewriting and redefining are important components of successful problem solving and presenting their final ideas.
Keeping **journals** on how they arrived at a solution is also a way of linking math with language and enhancing their written communicative skills. Children can also reinterpret their ideas through rods, blocks, cubes, measuring tools, calculators and a variety of other materials.

To this, I would add the goal that students learn to **value mathematics** and see it as relevant to their lives. If we can find mathematical tasks that children really use, like laying out snack, cooking recipes, measuring distances and comparing modes of travel, graphing of opinions; if everything we do in the classroom can be seen for its potential as a mathematical task, then students will see that they really do need math in their lives. Moreso if we take mathematical tasks and integrate them with other classroom activities, like writing [language!] mathematical journals where children write about the way they worked at a problem; science, humanities and even art [especially design] and music, then we create more opportunites for diverse mathematical applications, There is nothing new in what I have just said. It is just that in our tighter than tight schedules we teachers often lose stamina to make this extra effort. If we see our classroom as a WHOLE MATHEMATICS CLASSROOM then this elusive goal may remain in sharper focus.

19

HERE IS AN EXAMPLE OF SOME REVOLUTIONARY WORK DONE IN A CONSTRUCTIVIST CLASSROOM

When students go to the university they enter the world of abstract math: higher order math, math beyond numbers. This is the world the constructivist classroom attempts to offer students by giving them an opportunity to go beyond paper-and-pencil-two-dimensional-math into a world of dynamic, spatial, three dimensional, manipulative, open-ended math. Children who actually generate their own way of solving mathematical problems, have a deeper understanding of mathematical concepts and functions, as opposed to people who regard math as a collection of rules and definitions.

Constructive mathematics will take "much longer" than traditional math. It will be deeper, and it will be real and eventually there will be a leveling out. Research has shown that the children who have been allowed to learn math at their own pace have been able to construct the **algorithms** that would have otherwise been imposed upon them, but in addition they would have acquired a higher level of thinking. [Kamii & De Clark, 1985].

In fact an article by Mandel in Arithmetic Today [1985] told of a school in New York City where children were not taught algorithms till 3rd grade ! Without algorithms children devised their own strategies for solving mathematical problems [Kamii, Lewis and Livingston]. They come to view mathematics as an exercise in reasoning not memorization. Research also proved that children who were not taught algorithms had a better sense of place value, looked at numbers in their entirety and not as column [e.g., 5+6, carry 1] therefore, had a better number sense.

While mathematics can be flexible, nothing is arbitrary, 18 + 17 = 35 in all cultures, but there are numerous ways of getting there. These sums were constructed by children without formally being taught algorithms

A	B	C
18 + 17 =	**18 + 17 =**	**18 + 17 =**
working of student A	Working of student B	Working of s tudent C
10 + 10 = 20	10 + 10 = 20	10 + 10 = 20
8 + 7 = 15	8 + 2 = another 10	7 + 7 = 14
20 + 10 = 30	20 + 10 = 30	14 + 1 = 15
30 + 5 = 35.	30 + 5 = 35	20 + 10 = 30
		30 + 5 = 35

[Kamii, Lewis and Livingston p.201]

Instead of saying all roads lead to Rome, the principle here is there are many routes to Rome.

The algorithms taught in school are a convention, they are arbitrary, They are another human's invention. They are practiced differently in different parts of the world. There is absolutely nothing sacred about them.

Division algorithm ~ 260 : 4 =	Division Algorithm from Laos ~ 65 : 2 =
6 5	65 I 2
4 I 260	3I
- 24	05 I 32.5
20	- 4 I
- 20	10
0	- 10
	0

A last word about the teaching of mathematics. Researchers, most parents and all children, will agree that the most pleasant and most productive moments of a child's life is when they are engaged in play. If we teachers could take the sting out of mathematics and turn it into a game, into an interactive social event, into a flexible exploration, the chill that the term 'math class' brings to many hearts could be thawed into a love for the subject.

Why do I speak with such passion? I am a math phobic student who fell in love with the subject when I had to break it down and reconstruct my understanding of it to teach my students.

PART V:

AGE APPROPRIATE TASKS.

20
Introduction

Once we have no text book to follow how do we teachers know what to teach our students ? The first premise of a constructivist classroom is that children have their own continuum of learning . Each child will grasp the concept and learn as soon as they are developmentally ready to handle the task.

Developmentally, the young child is actually learning by making actual, physical neurological connections within their brain. The greater the diversity of tasks, the greater the connections.We cannot accelerate the pace of each child's development, but by learning to recognize the stages in a child's development we can provide just the correct stimulus and in doing so we can enrich these neurological connections ,thereby enhancing and enriching the child's learning.

In a constructivist classroom a teacher is not only a guide and partner in a child's learning, but also a careful assessor. The 'trick' is to provide such open ended materials and structure within the classroom , so that children at different levels of development can work together.

Since in a constructivist classroom our class syllabus and curriculum is determined by a child's stage and pace of development, a knowledge of child development is imperative.

21

AGE APPROPRIATE TASKS ~ A DEVELOPMENTAL APPROACH TO THE TEACHING OF MATHEMATICS.

To have a successful constructivist classroom we educators need to focus on the child's ability to learn more than a teacher's ability to teach.
This chapter will touch upon: ~
> What actually is believed to happen in the brain when a child learns, and how appropriate inputs at strategic points in a child's development can actually enhance a child's neurological connections.
> The theories of child development that will guide our curriculum and the expectation we have of our classrooms.

Great strides have been made in the teaching of Mathematics in the elementary classrooms. These are not only strides in the method of teaching mathematics but changes in our philosophy of teaching Math in the classrooms. Some of the reasons for these changes can be attributed to the way we view children's learning. Is this capacity to learn genetic or environmental? Do we educators and care givers determine a child's level of learning?

22

A CASE FOR THE THIRD 'N' IN THE NATURE-NURTURE DEBATE: A CASE FOR NEURONS

Our genes only determine our brain's main circuitry. Our environment determines the rest of the 'wiring' that takes place in our wondrously complex brain. There are two broad stages of brain wiring, " an early period when experience is not required and a later one when it is." [developmental Neurobiologist Carla Shatz of Berkeley - Newsweek Feb. 19/1996] It is this flood of "sensory experiences . . . that refine the blue print" our genes have laid out for us [Shatz, Time, Feb. 3/1997]

In these articles it states, what is critical is the - time limits, optimum periods, '*windows*' that the brain opens and closes as a child matures. The period a brain region takes to mature dictates how long the circuit connections remain malleable. Example, sensory areas mature in early childhood, the emotional limbic system by puberty, the seat of understanding continues to develop till at least 16. [Newsweek Feb.19/1996]. What, this in fact means, is that with the right inputs at the right time almost anything is possible. The other side of the coin is, that if you miss the 'window', damage can be irreversible. Connections are not formed willy nilly, but are promoted by activity."[Newsweek Feb. 19/1996]. By *the age of ten years the brain begins to eliminate connections or synapses that have not been 'magically transformed by experience.* ***Rich experiences on the other hand do 'produce rich brains'*** [Time, Feb. 3/1997].

If we who fashion curriculum looked at education through the prisms of biology, more specifically through the lens of neurological development, we would include all we term "extra curricular / co-curricular / irrelevant curricular" as part of the core

of our curriculum. "Lectures, worksheets and rote memorization would be replaced by hands on material . . . drama, project work . . . music, gym, . . . a second language and geometry would be offered to much younger children . . . and teachers would pay greater attention to children's emotional connection to the subject" [Newsweek Feb. 19/1996].

Is this just expensive, elitist mutterings? No! Gym classes may be a time for physical activity, but this very physical activity 'juices up the brain' feeding it nutrients like glucose, and increasing nerve connections! Numerous studies have shown that children who exercise as opposed to sitting sedentary do better in school. Within a constructivist classroom, where students are physically active, as opposed to those sitting quietly memorizing facts, they actually make deeper connections. Robert Sylwester in his paper "A Celebration of Neurons"- [Time, Feb. 3/1997] describes how a constructivist classroom can actually make more intense neurological connections: "The smell of glue enters memory through one sensory system, the touch of a wooden block through another, the sight of the..[finished work] . . . through still another. The brain then creates a multidimensional mental model of the experience - one actually easier to retrieve" - [Newsweek Feb. 19/1996]

So what do all these experience driven neurological connections have to do with the teaching of mathematics? Mathematical ability is not genetically coded into us, but there are undoubtedly some people who have a mathematical sense. What is this sense, and why don't all of us have it?

Patricia Davidson began researching the neurological implications of learning math in 1967. She found that the left and right sides of the brain, each favored a different style of learning math. [The following table is Handout # 5]

RIGHT SIDE OF THE BRAIN	LEFT SIDE OF THE BRAIN.
>Nonverbal, simultaneous, holistic approach to information. > Spatial sense, the part of the brain used to finding ones way around. > Makes sensory discriminations.	>Processes information in a sequential, linear and analytical manner. > Plays a role in reading, writing and computation.
> Physical, intuitive and creative people >It has an aesthetic sense, i.e., the side of the brain used to appreciate a painting.	>Highly verbal, logical, organization-oriented individuals.
At the age of 5-6 boys demand and get more time with rods, and blocks. They are stimulating the right part of their brain, which sets them up later for better spatial reasoning, and an ability to estimate.	At the age of 5-6 the left hemisphere of girls is more highly developed. They tend to be better at computation as this requires a step by step approach and memorization of facts. Because these skills are considered desirable in traditional schools, girls may lose out on developing skills that will stimulate their right hemispheres.
Math style of a right hemisphere person ~ [Davidson's 'style II']. >Good at counting backwards. >Understands subtraction and division. >Does not enjoy step-by- step approaches to math and makes mistakes. >Good at estimating. >May spontaneously give a correct answer without knowing why. >Recognizes large scale patterns. >Enjoys geometric and three dimensional configurations. >May actually have a better understanding of math problems, but are impatient and imprecise.	**Math style of a left hemisphere person ~** [Davidson's 'style I'] >Better at counting forward. >Understands addition and multiplication. >Prefers a recipe approach, a step-by-step sequence. >Seldom estimates. >Remember parts not wholes. >Need to talk themselves through procedures. >Precise in their working. >Do not have a logical assessment of their work. Are more interested in *how* than *why*.

[Loviglio on Davidson - Massachusetts Teacher 1981]

In a word a child who works favoring the left side of their brain will use mathematical formulas, but without really needing to know why they are doing so. This ability is greatly appreciated by the traditional system of education. Paper and pencil mathematics leaves the right hemisphere of the brain relatively untouched.

Davidson believes that tactile and spatial experiences a child can get from math manipulatives and materials such as blocks, clay, music rhythm and art, are critical for the development of the brain's right hemisphere. As noted earlier, by the age of ten, unused synapses close down. This is also the time when the corpus callosum, a bundle of nerve tissues that connect the two hemispheres develops and integrates their operations. Now, for the first time, a child will be able to use both hemisphere to perform a task. This however will not have much benefits if both the hemispheres are not independently developed.

23

A CASE FOR A STUDY OF CHILD DEVELOPMENT IN PLANNING A MATH CURRICULUM

How do we ensure that individual children receive the experience that is best for them? Mass produced, standardized education, is not the answer. To teach our class successfully we have to plan **activities for each child's level of development**. How do we determine this continuum while teaching math to children?

The aim of the rest of this chapter is to show how important it is for educators to understand the child's stage of development before teaching children mathematical concepts. For this we have to look to the works of Piaget and Vygotsky. Without this background it is almost impossible for a teacher to plan and implement a joyous and successful curriculum. This chapter is my personal journey of this discovery. I have used readings from researchers in the field. The arena of mathematics is so large that I have only touched the tip of the iceberg. However it has already radically changed the way I view the teaching and learning of math in the classroom.

First, let us first talk about the way math is traditionally taught. [See handout #3] math is viewed as an absolute. Problems are closed ended. They can be solved through one method and have a fixed solution. Q.E.D.! The traditional tool of teaching mathematics is paper and pencil algorithms, with text books, work sheets, and some manipulatives to help the children understand numbers by actually, physically "learning by doing." The adult is the authority and the children practice long and hard to match the skills the adult is handing down to them. In a group of 100 traditionally taught adults I wonder how many remember their math classes with affection and how many with dread?

To be able to learn in a progressive CONSTRUCTIVST classroom, the children must create their own understanding of mathematics, at their own pace. To be able to follow this method we attend to Piaget and his stages of a child's cognitive development.

Piaget has had his critics, and his theory has had its share of revision. The original emphasis on stages has given way to a consideration on the mechanisms that underlie all stages of development [Labinowicz, 1980]. Piaget did not seek to deny or dispute the other theories of learning - conditioning, imitation, reinforcement, association, modeling mechanisms. He gave it a different perspective [Vaidya, 1991]. His theory is a powerful explanation of higher-level functioning such as understanding the relationships in a logical-mathematic perspective [Labinowicz, 1980].

Piaget has several assumptions regarding children's learning. He believed: -
> Children are active learners. They determine their own development.
> Cognitive development takes place in stages and each of these stages has its own sub stages which follow each other in succession.
> Higher mental processes evolve out of lower mental processes. This hierarchical development is more spiral than linear with the same notions being worked out again and again at higher levels of development [Vaidya, 1991].

Piaget saw four components of development.
Maturation ~ Represents a level of growth. It can be viewed by an educator as a restriction to the amount a child can be expected to achieve at a particular age.
Experience ~ Experience is necessary at all stages of development. Children act on objects. They learn to compare, discriminate, transpose, and form concepts. In order to become competent children develop '*operations*', [schemes of thought] which help in problem solving and making sense of the world.
Social environment ~ Young children are egocentric and feel no obligation to

make sense to others or to exchange a point of view. The obligation to reason logically, to be objective, grows out of social interaction. Through this medium children learn about their environment and social customs of their community. Piaget believed that social interaction was indespensible for the child's ability to develop logic [Kamii, 1985]. The more children interact with their social environment, the more they will be exposed to, and the more they will become aware of other points of view. As they become more sociocentric children will begin to listen to and exchange information.

Equilibrium ~ As children encounter their environment, they experience periods of *disequilibrium*, when their image of the world [or more simply put: their plans] do not work. They then have to reconstruct their knowledge. There are two methods of reconstructing knowledge. Children can either *assimilate* the new experience that is they fit it into an existing framework of knowledge, e.g., A cat and a squirrel are both furry so they fall into a single category. This method to resist change helps us maintain a continuous intellectual development. [Labinowicz, 1980].

On the other hand the new input can enrich knowledge and children *accommodate* their concepts and actions. E.g.. A child uses a new angle to kick the ball into the goal. The accommodation of new inputs ensures an extension of our understanding. When these two strategies have been resolved and integrated, the child has '*constructed a solution*' and attained a higher state of equilibrium. [Labinowicz, 1980]

The children this paper will deal with will be elementary school children. The children in elementary school come under the range of what Piaget called the **Preoperational** and **operational stages**.

Preopertional stage [representational] **and prelogical thought** - The child no longer need to act out situations externally but can represent them with action or words. The child however cannot think logically, cannot return an object to its

original state and cannot consider another's point of view. They cannot see two aspects of the same object. Preoperational children classify in one unit. A ring can be bigger, but not bigger and smaller. This is also reflected in concepts of one and many. [Labinowicz, 1980]

Concrete Operational stage period of logical thought - The child becomes capable of logical thought in relation to physical objects. There is reversibility of thought, the child can hold two or more variables while classifying, the child can reconcile apparently contradictory data. The child also becomes more socio-centric. The child now begins to conserve The child's thinking however is restricted to concrete objects rather than abstract ideas [Labinowicz, 1980]. Each of these stages are built upon the other, and there is considerable overlap. [Labinowicz, 1980].

The watershed in the children's understanding of mathematics lies in their ability to conserve. What is Conservation? It is the ability to coordinate reason and perception. As long as the children are preoperational and perception bound they base their answers on what the objects look like, the physical arrangement of the objects, not upon rational understanding. It has been proved that it serves no purpose to try to teach children conservation [Kammi, 1982]

The stages of development and the ability to conserve had a great impact on how the children acquire knowledge, what their understanding and responses will be, and the level of teacher expectations.

Noting the above and the cognitive leaps children continuously make, I feel one way of thinking about Piaget's view of a child's knowledge is to compare it to the Hindu philosophical term *maya*. *Maya* is an illusion of reality that we believe in this present state, to be true, but is transitory and open to change. Material wealth, especially money is a true example of *maya*. Now you have it, now you don't. Purchasing with a credit card is even more so! It is an illusion of wealth!

In mathematics Piaget conceptualized two types of knowledge -

Physical Knowledge- knowledge of objects in an external reality. This involves things that are known through observation. The knowledge dwells within the object, e.g., The color and shape of a small red bead. [Kamii & De Clark, 1985]] These are obvious, apparent and independent of any other influence.

Logico-mathematical Knowledge - Involves the knowledge of relationships between objects. What is the difference or the sameness between two objects? The differences do not dwell in the objects, but in the comparison between them. The source of the knowledge is in the individua'ls perception, e.g., a small red bead and a large blue bead. If the beads were not put into a relationship, the relationships would not exist. What are these relationships? A child can compare their size, color, and the quantity of 2 that the big blue bead and the small red bead make [Kamii & De Clark, 1985].

Piaget also mentioned a third knowledge -

Social Knowledge ~ These are conventions worked out by the society a child lives in. Christmas means something quite different to people on either side of the equator.

A word of warning: Piaget was concerned that his theory would be used to try to accelerate learning. He believed that actually trying to 'teach' his methods, i.e., conservation, would be less effective than doing nothing at all. He was concerned that such structured guidance would create a dependence that would interfere with a child's independent intellectual explorations [Labinowicz, 1980]

I end this chapter with a brief introduction to Lev Vygotsky. While Vygotsky had definite views on child development, for me, personally, his theories are an invaluable guide to my role as a teacher in a constructivist classroom. Vygotsky believed that there was a *zone of proximal development* or ZPD. A child can achieve a certain level working alone. When working with a more competent other or even within a group [Moll and Whitmore, 1993 in Berk and Winsler, 1995], the

child is lifted to a newer level of accomplishment. This is the child's potential to learn. The difference in the two achievements is the ZPD [Berk and Winsler, 1995]. I have personally experienced this while studying at Bank Street, where, through discussions, and doors opened by others, my thoughts have reached areas where I never could have taken them on my own. It is not merely knowledge that I gained, these discussions became ladders/stepping stones for my ideas, or vacuumed cobwebs from my mind.

In Vygotsky's theory, children's problem solving improved when working with an 'expert'. The role of the expert was not so much to provide the answers but scaffold a child's learning. The metaphor of scaffolding speaks to a more competent other who is sensitively tuned to the needs of each child [Berk and Winsler, 1995]. This touches upon not what the child has mastered, but upon tasks that are in the process of development. The child stretches to understand the perspective of another and is therefore drawn into a different and broader approach to the situation [Berk and Winsler, 1995].

How does one achieve this by supporting the child's initiative and autonomy?
>First the emotional tone needs to be warm, supportive and non judgmental.
>The adult's goals need to be clear - scaffolding and enhancing the child's development and learning, not guiding the child to a 'correct response'.
> Scaffolding could be described as a dance between the child and adult with the child leading and the adult following, giving clues where needed.
[Berk and Winsler, 1995].

An excellent example of scaffolding is the breaking down of tasks or ' chunking', so that each 'morsel' is commensurate with the child's momentary competence. The teachers need to know their students so well that:
> They are able to structure each activity to the child's competence.
>They can constantly readjust the amount of adult intervention to the child's

growing competence, till the child can function independently. The adult should only intervene when the child is truly stuck. In schools I have heard about and have visited, several classes have the rule that a child in doubt has to ask three classmates for help before coming to the teacher.

A Vygotskian approach to mathematics would entail two important components. The first is structuring the classroom, where the teacher is very specific on how the class is to be structured and the procedures the children need to follow. The second is the actual mathematical reasoning, where the teacher takes the backseat.

In the structuring of the class procedure *the teacher ensures* that the children work collaboratively, engage in dialogue, think about and justify how they are solving the problems [meta- mathematical thinking!], come to a consensus, feel free to make mistakes, and learn how to use their mistakes to further their learning. In short the teacher provides a social environment that is conducive to learning. [Berk and Winsler, 1995].

A Vygotsky-based mathematics construction of mathematical knowledge is not an adult- imposed system or a private problem solving activity, but a community endeavor of teachers and children. While learning mathematics, the children will also practice the qualities of citizenship that a democratic nation would need.

How would a sensitive teacher determine such a curriculum?
First the teachers must feel the need to have such a classroom. To genuinely believe, an educator must experience a cooperative environment, where the process of problem solving is enhanced by working cooperatively with ones peers.

PART -IV

WORKSHOP

24
Introduction

Using India's Historical Background as a starting point, I wish to state our education is too grounded in our text books. Mahatma Gandhi believed that literacy was a tool of education, not the end product. His educational policy aimed at developing qualities of head and heart beyond exams and assessments.He wished children to be physically involved in what they were doing. He advocated a crafts curriculum, in which children were deeply steeped in their culture as well as open minded to others.

Gandhi's craft curriculum may no longer fit into our computer aged classrooms.By having a progressive classroom, we can adopt the essence of his philosophy.Using a constructivist curriculum to hone the intellect, and a social learning to enhance the heart, I wish to show how a progressive approach to learning can be brought into our Indian elementary classrooms.

As a teacher in my own right, and after conducting three demonstrations, I can vouch for the fact that Indian elementary teachers are open and eager to be exposed to new ideas. The workshops described in the following pages, are to expose them to the concept that math need not be a rigid paper and pencil exercise, and that cooperative learning will not only free time and space for the teacher, but give the children the freedom to learn from each other.

25

LET LEARNING REALLY BEGIN

The workshops that I would like to do in India, or for that matter anywhere in the world, would be to introduce ***Nursery and Kindergarten Teachers to teaching Math through the constructivist curriculum.***

My aim would be to model the constructivist approach in the workshops, allowing the teachers to experience for themselves the power of learning with ones peers, and the intensity and joy of discovering and formulation ones own hypotheses and answers.

26

THE AIM AND SCOPE OF THE WORKSHOPS

Throughout this study I have focused on a framework for developing classroom explorations. This series of three workshops will be aimed at providing the teachers with a new context for operating within their classrooms. Ideally I would like to do them a week apart so that teachers' can mull over what they have experienced, and see how they could bring it into their classrooms.
I find it difficult to think in terms of a 'single complete workshop' as the time and interest of the schools would provide the parameters in which I would be able to work. The attitudes of the teachers, their openness, would all be factors I would have to gauge on the spot.
However having attended and conducted demonstrations, I can vouch for the fact that there is a great thirst for knowledge among Indian elementary school teachers. I can already hear their objections to my presentations, their large classes, traditional desk and chair settings, the pressure of a set syllabus, the weight of tests, exams and end of term assessments, the standardization of expectations and most of all the resource crunch that most of our schools face. My aims are therefore very modest. I can never dream of sweeping changes, but I know other individuals have and can make a difference. So from my beginnings as a small voice, drop by drop, presentation by presentation, day after day, I am sure I will make a difference. I will aim to influence the one resource that is boundless and free, *teacher attitude and effort*.

For the successful implementation of the workshops I hope to have a two pronged effect. One I hope to be able to affect the teacher's attitude. The other is to introduce the social context for learning. I wish for them to experience, enjoy and therefore feel motivated to implement the power of
~ Genuine problem solving.

~ Working in a group, and relying on ones peers and not merely on the teacher / instructor.

~ To understand that the process of arriving at an answer is as powerful and fruitful whether the answer is correct or not.

~ That hands on problem solving and being able to think about the process used to solve it, and present the solution only enhances ones understanding of the problem, and therefore of math.

~ That the skills a constructivist classroom enhances are the skills the children will use through their lives.

As I have mentioned earlier, the workshops can be formulated and presented a week apart depending on the requirement of the teachers. I can see the following materials being developed into workshops. Before I begin my workshops in India, I will have material ready on the various aspects of teaching math: ~

> Classification and finding and analyzing patterns.

> Math games.

> One-to-one correspondence, counting and numberness.

> Prediction and estimating.

> Presenting the process through journals, manipulatives, graphs, pictures or stories.

> Tasks that involve and foster conservation.

> Geometry and Measurement.

> Graphing

> Manipulatives.

> A social context to learning.

> Scaffolding children's learning. [See appendixes]

> Equity and expectation: Mathematics and gender. [See appendixes]

All the workshops will have a format similar to "Abolishing Absolutes, an openended approach to problem solving."

I will start by briefly **introducing** myself and the aims of the workshop, taking the participants through the areas we hope to cover, within the time frame allotted.

I will use a **task to focus the group** into the direction the workshop is taking. This will be an introspective moment when the teachers will be encouraged to look within them selves. Depending upon the size of the group, we will try to draw up an experience chart.

I then intend to show them a **short slide show**, so that they can see a class functioning. This will help us build a common vocabulary, and will give what I am trying to portray a certain credibility.

I will then divide them into groups, preferably ones that do not normally work together.
They will all be asked to do an **assignment**, come to a consensus and then present it to the group. I will be careful to explain that each team member has to have a function, as every member of the team must have understood the problem and come to a working consensus regarding the solution. Cooperation will be emphasized. Agreeing to disagree is perfectly legitimate provided they can articulate the other team members argument. [At this point if there is time for a break, we will have one.] In the end their solution will be presented to the group, and be open to questions.
We will then **analyze the experience** that involved problem solving, exploring the task as a group. We will definitely focus on the diversity of approaches.
I will **show them a more specific set of slides** on the topic of the workshop, with the participants now being welcomed to comment, question and relate what they see to their own experiences as learners and teachers.
We will then try to **create a curriculum piece** or a task, discuss how it can be presented in a concrete way to young children with the *answer becoming a part of the discussion, not the end product.*

Finally we shall **discuss the nuts and bolts** of teaching using the problems created by the participants of the workshop in a classroom.

LET'S GET TO WORK!

WORKSHOP # 1 - 3.

ABOLISHING ABSOLUTES:

A QUEST FOR OPENENDEDNESS.

BRINGING

CONSTRUCTIVIST MATH

TO THE

EARLY CHILDHOOD CLASSROOM.

27

A HANDOUT GIVEN TO ALL THE PARTICIPANTS.

WORK SHOP SESSION # 1 ~

1/- Introduction and Welcome.

2/- Outline on the purpose of the workshop, and establishing a rationale for the workshop.

3/- Two whole group tasks: I- A reflection of ones early experience with Math as a student and later as a teacher. II- An analysis of employment.

4/- What is a constructivist math classroom?

5/- Slide show - A constructivist Kindergarten Math classroom in America.

6/- Discussion.

7/- Closure.

WORKSHOP SESSION # 2 ~

1/- Group process ~ solving an open ended *genuine* math problem.

2/- Analysis of working on the problems and group dynamics.

3/- Slide show - Problem solving in a Kindergarten classroom.

4/- Discussion

5/- Closure.

WORKSHOP SESSION # 3 ~

1/- Recapitulation of workshops 1 and 2.

2/- What are the learnings from the two former workshops. Charting new learnings.

3/- Group process: Creating a curriculum piece. Creating open-ended problems.

4/- Presenting and discussion of the problems.

5/- Reflection on the three sessions experience and future implications.

6 /- Closure.

28

MATERIALS NEEDED FOR EACH WORKSHOP:

WORKSHOP # 1

> My notes.

> Name tags for everyone should already have been given out.

> A letter from me out lining my aims for the workshop.

> Individual programmes for each participant.

> Pencils and paper for the participants.

> Scotch tape and push pins.

> Large butterfly clips to hold experience charts.

> A black board or large sheets of paper with headings.

> Large papers and markers, or blackboard and chalk to write a collective experience chart.

> A large chart with the workshop itinerary written out will be prominently displayed.

> Slide projector, screen, slides, pointer, torch.

> A bell

WORKSHOP # 2

> Slides set in a carousel.

> Slide projector and screen.

> Torch,

> Notes,

> Hand outs,

> Pencils and paper for the participants.

> Scotch tape and push pins.

> Large butterfly clips to hold experience charts.

> Large papers and markers, or blackboard and chalk to write a collective experience chart.

> A large chart with the workshop itinerary written out will be prominently displayed.

> A bell

WORKSHOP # 3

> Pencils and paper for the participants.

> Scotch tape and push pins.

> Large butterfly clips to hold experience charts.

> Large papers and markers, or blackboard and chalk to write a collective experience chart.

> A large chart with the workshop itinerary written out will be prominently displayed.

> Slides set in a carousel.

> Slide projector and screen

> A small packet of handouts of their earlier experience charts to take home.

> Materials to work on a problem: pad, pencils, Crayons, manipulatives, counters, paper, scissors, glue.

> Experience charts done in the previous workshop to be displayed.

> Music to play softly while they are working.

> A bell

Estimated Time-Table for Three Workshops:

Workshop 1: **Introductions and Introspections.**

1	Introduction and welcome	5 minutes
2	Rationale for the workshops	5 minutes
	Question and discussions	1 5 minutes
3	Whole group task I : Introspection Introduction Task Discussion Whole group task II : Job analysis Qualities search Common factors Discussion. Total time	 5 minutes 15-20 min. 20 minutes 15 minutes 15 minutes 10 minutes 1 ½ hours.
	Break	
4	Why math ? My script : Discussion and questions	15-20 min. 15 minutes.
	Lunch	
5	Slide show : A Constructivist Kindergarten. Discussion in individual groups. Making an experience chart.	20 minutes 15+30 min. [flexible]
	Approximate total time.	**3 ½ hours**

Workshop 2 :**Abolishing Absolutes and the Experience of Social Learning.**

1	**An Assignment** : Recapitulation My script Solving an open ended problem in a group setting Total time	20 minutes 1 hour 1 hr. 20 min.
	Break	
2	**Analysis** : Open ended problems. Working in a group.	30 minutes. 10+30 min. 1hr 10 min.

	Lunch Break	
3	Specific Slide Show and Discussion.	60 - 90 min.
	Approximate total time	**4 hours**

Workshop 3: **Creating an Open Ended Genuine Problem**.

1	Welcome and Introduction: Recapitulation of previous workshops	10 miutes 20 minutes
2	Charting their own experiences	15 minutes
	Break	
3	Creating a Genuine Problem	1 hour
4	Presentation and Discussion	30 minutes
	Break	
5	A Time for Questions. Reflections and Evaluations	1 hour 40 minutes
6	Closure:Summing up and Conclusions.	10 minutes
	Approximate total time	**4 hours**

29

ABOLISHING ABSOLUTES

A QUEST FOR OPENENDEDNESS.

A WORKSHOP IN THREE PARTS.

TIME FRAME ~ This would be a workshop in three parts. I would prefer to do them over a period of three mornings a week apart. They could also be done in one day, with two breaks in between, but I do not feel the participants will have time to take it all in, use what they have learned and bring their concerns to the class.

30

SESSION # 1:

INTRODUCTIONS AND INTROSPECTIONS

Day 1:

SESSION # 1: INTRODUCTIONS AND INTROSPECTIONS

PURPOSE ~ *To give the participants a background of the shift in my attitude toward education and to help them see the relevance of progressive education in the lives of the children. By talking about Gandhi I wish to emphasize that what I am saying is not alien to India.*

There will also be HANDOUTS:
1- An introductory letter to the teachers, informally stating my aims and the content of the workshops.
2- A break up of the three workshops.
3- A comparison between the Traditional and Constructivist method of education
4- A comparison between the functioning of the right and left hemispheres of the brain with regard to math.
5- The problem sums.

1/- INTRODUCTION AND WELCOME

[5 minutes]
MY SCRIPT: I had taught in India for 10 years before my husband was posted to New York in 1994. I had always thought of myself as a progressive teacher, until I joined the Bank Street College of Education and realized that "Progressive" had a completely different connotation. The aim of this workshop is to share with you the experience, both as a student in college, and as a nursery and kindergarten teacher, in "progressive" institutions.

As an N - 5 elementary teacher, in India, I believed the goal of education was to produce productive individuals for society. I was also taught to believe that knowledge was the ultimate aspiration in education. I made it my personal quest to pass knowledge onto my students with as much enjoyment and hands on experience as I could. That is what I tried to do. I tried to be as entertaining as

possible. I tried to make magic for my pupils. I tried to make the knowledge I imparted meaningful to my students. I followed the thematic approach, I made up stories, wrote songs and poems. My classes were so entertaining the children couldn't wait to get back to see the next episode Later I came to regard the enhancing of my students' skills to be my primary concern, and I felt the knowledge that I wanted to pass on to them would follow. Have you noticed how many times I used the personal pronoun . . . yes, I was the center of the class room, the font of all knowledge, I was the authority, judge and jury.
On being exposed to the progressive school of education, both as student and teacher I have come to firmly believe that education dwells within the learner. A teacher's task is not to teach, but to create an environment where the learner learns to seek knowledge. However powerful and exciting knowledge is, it can also be a boundary, an end product. Now I believe the essence of education is the process of constructing knowledge. What we follow in India is the "traditional " educational approach. And as I described, I was a traditional teacher. I am sure many of you catch glimpses of yourselves in the description I gave of my self.

There is another view of education. That is "progressive " education. The "Father of the Progressive movement" was a person called John Dewey. I will now attempt to link Dewey's educational philosophies with Gandhi ji's educational philosophy.

I was enchanted by the progressive school of thought. In the progressive school we deal with the children as a group of problem solving individuals. Our task, as teachers, was not to give them the answers, but to draw the answers out of them. The depth of the children's insights astounded and educated me. I am still striving to be a progressive teacher.

I wanted to bring Dewey's pragmatic philosophy to India, but hesitated to foist an alien educational system onto you. It was while researching John Dewey that I

encountered Gandhi ji's well thought out educational policy. Gandhi ji was very much a progressive educator.

Looking at the works of both Gandhi ji and Dewey, I feel:

>They both had a social and educational theory and they both shared common aspirations.

>They both believed education went beyond text books and literacy.

>They both believed that the curriculum dwelt with in the environment of the children.

>And they both believed in respecting the rich diversity of our culture and using that as a resource.

By this work shop I wish to share the essence of what both Gandhi ji and John Dewey believed.

2/- A RATIONALE FOR THE WORKSHOP.

[5 minutes]

Why do I want to change Indian education? There is one component in our contemporary experience that is unique in our history. To understand Indian education we need to go back in history. From 5,000 B.C.to 1947 our history has had waves of conquests and occupation alternated by golden ages of prosperity and growth. Except the British, the conquering people stayed and ruled, and we obeyed and molded ourselves the best we could. Never once in the history of our nation, till 1935 when the British *Sarkar** [government] gave us a chance to choose the members in the provincial assemblies did the common people influence our government. It was finally in 1950 when we adopted our constitution that India become a democracy and every individual, Indian adult had a part to play and real choice and voice in the government they wanted.

This is the main divergence from our past. We have the advantage of a geographical unity, a common economic goal, and the ability to actively play a role in selecting our government. In essence today we have unity and we have **choice**. We are a *democracy*. But our education system is still rooted in an archaic past.

Is democracy merely political or is it a way of life? In India is democracy a political goal or a way of life? That is the dichotomy. Democracy is so new, and our traditional obedience so deep that even making choices need to be learned.

For a democratic country its citizens must know how to **make choices** without being swayed by popular culture or being pressured by authority. To be productive citizens we need to **work cooperatively in a group**, contributing and negotiating toward our common goal. If we believe that these skills are imperative life skills, then we must allow our youngest citizens, our children, to learn and refine them from their childhood. I genuinely believe education is more than literacy. Education must also include an active socialization between the children, which is tried tested and learned over the years, not handed down by a book of

etiquette. *Social learning and autonomy should be an integral part of our lives, and therefore must be a prominent part of our educational curriculum.*

The classroom that will enhance democracy as a way of life is what is known as a constructivist classroom. The aim of this workshop is to show you a glimpse of teaching mathematics in a constructivist classroom.

Questions and discussions: The participants will now be given an opportunity to share their experiences, ask questions and clear or elaborate on any points made during this session.
[15 minutes]

OUTCOME ~ To inform the group of my stand regarding education.

3/- WHOLE GROUP TASK ~

A reflection.

PART I~ Introspection.

To be done with the participants. This depends on the size of the group. The teachers will usually know each other so I need not spend too much time breaking the ice, but more on setting the mood.

PURPOSE ~

The aim of this section of the workshop will be to create a personal involvement with participants. The experience chart will help them look into their own lives and their own methods of functioning and bring their experiences to the workshop.

METHOD ~

15 minutes, an average of 30 seconds a participant.

Numbers permitting, the teacher's will sit around in a circle. They will introduce themselves and talk briefly about their recollections of their experience with math. How do they remember their classrooms as students? How did these classes affect their own attitude toward math?

DISCUSSION ~

20 minutes

Once their attitudes have been summarized, they will work in twos or threes and chart out their expectations and attitudes as teachers and what do they think is the attitude of their students to mathematics? As the discussion occurs, I will also try to focus on different aptitudes for math, styles of learning and gender equity.

OUTCOMES ~ The teachers get to review their personal experiences and attitudes toward Math, so the workshop can resonate with their own lives.

AND / OR

PART II ~ Analysis of employment and math skills.

STEP 1

15 minutes

> Divide the participants into groups. Asking them if they were to hire a ----- what were the qualities would they look for?

A domestic servant.	A journalist
An executive.	A teacher
A clerk.	A scientist

STEP 2

15 minutes

What would the common factors be, and what would be the significant differences?

OUTCOMES ~ Using this chart I hope to establish the desired qualities in a person contributing to their community, like problem solving, cooperation, initiative, integrity. I would also like to emphasize qualities that leaders of a community would assume like autonomy and the ability to take calculated risks. This would give me the parameters for the next part of my presentation.

DISCUSSION AND QUESTIONS ~

10 minutes

Note - If there is a shortage of time, the first task will be reduced to participants merely volunteering their attitude toward Math. The emphasis will be on the second task.

Total time:1 ½ Hours.

BREAK.

4/- WHY DO WE NEED A CONSTRUCTIVIST CLASSROOM TO TEACH MATHEMATICS ?

MY SCRIPT:

15-20 minutes.

To convince parents and teachers that it is necessary to change our educational strategies and goals we need only look at the future employers of their children. The corporate and business houses are now looking for certain skills in their executives that go beyond academics.

[Using the charts that we have prepared during the workshop.]

> Information is the new capital, the new resource of our technological age. The person must know how to **independently** seek and access relevant information.

> With the rapid change in technology and the tendency for workers to change jobs, the employers will look for candidates that are flexible in their approach. Adaptability is the key to change. The candidates must be able to **adapt** their knowledge and skills to the ever changing technology that research brings. There are fewer and fewer absolutes in our world.

> **Problem solving** is a key to the success of an executive.

> Decision makers need to know how to function **collaboratively** feeding off diverse information, opinions, experience and styles of functioning so that all aspects of the problem can be studied.

> Another talent that the future employers are looking for is the ability to investigate and study data, **see and predict** trends and **patterns** that can be used to analyze information

> There is no doubt that markets are diverse. Diversity is more than new products and markets, diversity of experience, lifestyles, understanding, opinions is an economic necessity. To truly understand this diverse world, made quicker, but not smaller by technology and communications, a competent **diverse** workforce is the need of the day.

Learning is a social process. A constructivist classroom is one where everyone in the class is involved in problem solving, discovering, inventing, explaining, negotiating, sharing and evaluating.

To explain the functioning of a constructivist classroom let us compare some aspects of teaching mathes with those of a traditional classroom.
Please refer to your **Handout # 3.**

Comparison Between a Traditional and Constructivist Classroom

Task	Traditional Method	Constructivist Method
Method of working.	Text books and work sheets. The children memorize and regurgitate their responses.	Actively manipulate concrete objects. Relationships are discovered and become firm concepts for wider action later on.
Aim	To practice and perfect solving algorithms. The working can be done mechanically, checking answers at the back of the book. There is one way and one answer.	Children need: > to be autonomous and self motivated in their mathematical ability. > to discuss, reflect and make sense of the mathematical tasks and therefore procedures. >to feel responsible for making sense and communicating their mathematical reasoning, as opposed to merely completing a mathematical assignment.
How	Learning is done alone, usually with paper , pencils and perhaps a calculator. The work is mainly oral or written.	Learning takes place in a material and social environment. Children work in groups. Work is manipulative, oral & written.
Problem solving.	Once the algorithms have been mastered, the students are given word problems as a form of mastering the skill taught.	Problems are given first, they are open-ended with several methods to get to the answer. Children solve these concrete problem and discover the computation skills for them selves.

Assess ments	The teacher role is to make the text book and prescribed syllabus as palatable as possible. A few students may be asked to discuss and demonstrate the computations on the board. The teacher then corrects the work/ papers. There is no immediate feed-back as corrections take time, and children may not be able to correct their errors in understanding the problem or clarify difficulties immediately.	> Is not merely an asker and answerer of questions, but a partner in the learning process. Every student is also a teacher and learner in this shared process. >The adult's task is to constantly assess the children, not for the right answer, but their method of working, their developmental level and depth of understanding. >To provide them with appropriate tasks and materials with which children can construct, revise and find meaning through their own experience.

In a world which functions more and more in bytes, finance, flow charts and statistics, mathematics holds primacy. More and more mathematical skills are seeping into the normal functioning of an urban professional. On the other hand we can argue, in a world of calculators and computers, where do we need math? Yes the calculations are done, the procedures may be done , but to truly comprehend, those statistics and to be able to use and project them productively into our lives, we need to be mathematically literate .There is more to the teaching of math than meets the eye. There is a whole hidden curriculum that the constructivist, progressive classroom brings to the learning of math. My belief is that a progressive, autonomous, constructivist classroom enhances these very traits the future employers of our students seek.

DISCUSSION AND QUESTIONS~

15 minutes.

I will point out to them that the following slide show may answer several of their questions.

LUNCH BREAK

5/- **SLIDE SHOW ~**

A constructivist, whole math Kindergarten classroom.

20 minutes

Purpose ~ After having spoken about a constructivist classroom :

1/- This is to introduce the participants to what a progressive American Kindergarten classroom looks like, and help make the unknown known so the teachers in India can understand the context of my experiences.

2/-To generate a common vocabulary.

I will request the participants to limit their questions and discussions as there will be time later for such a discussion.

For the present the task of the slide show will be to:

Show a whole math environment.

Show children working at the same task at different levels.

Show a snack problem with a brief talk on conservation skills.

Show problem solving, and discussions occurring spontaneously and children helping and learning from each other.

Show children creating algorithms without knowing that they are performing conventional math functions.

Use manipulatives over paper and pencil mathes, a way of using both sides of the brain.

Outcomes ~ The participants having become somewhat familiarized with a functional constructivist classroom, will be able to see the energy and initiative children bring to their learning. They will also be able understand how "logical" [to the child] a young problem solvers thinking can be.

6/- **Discussion and closure**.

15 minutes.

Participants can first discuss among themselves as a group, while I walk around.

30 minute [Flexible time]

The Participants will join together as one large group for further discussions and a summation of the workshop.

Total time : 3 hours.

31

The first workshop sought to help the participants introspect about their own feeling about Math and introduce them to the functioning of a Constructivist Classroom

WORKSHOP

SESSION # 2 :

ABOLISHING ABSOLUTES AND THE EXPERIENCING OF SOCIAL LEARNING.

DAY : 2

SESSION # 2 : ABOLISHING ABSOLUTES AND THE EXPERIENCING OF SOCIAL LEARNING.

AN ASSIGNMENT ~ A Group Process ~ Solving an Open Ended *Genuine* Math Problem

1/- **RECAPITULATION ~**

10 minutes.

We will pull together salient points of the first session. This could be done by asking the participants or by reading the experience charts created by the end of the first workshop.

2/- **ASSIGNMENT ~**

1 hour

To give the participants an open ended problem that has several answers and many methods to solve it . To let them solve it in groups and present it after they have finished.

PURPOSE ~ *This is the heart of the presentation. This is to clearly demonstrate to the teachers that mathematics does not have to have absolutes, that there is diversity in methods , that one does not only learn from the teacher, but also from ones peers. To have the freedom to create ones own method of solving a problem enhances an understanding of math.*

MY SCRIPT :

10 minutes

You have been divided into groups. The task before you is to solve the problem given to you. This is called a genuine problem. For a long time I thought a genuine problem was a problem that touched the lives of children. In this case a

genuine problem is an open ended problem, that not only does not have a fixed answer, but it has different methods of arriving at the answer .All points of view must be listened to. Everybody has a turn to speak as well as a responsibility to the task, a job.

You will be asked to do a presentation at the end of the class. Other members of other groups are free to question or comment. There are certain parameters to consider.
>Only positive comments are allowed.

>Each member of your group must be given a job to do: mediator, time keeper, scribe, journalist, spokes-person, artist, materials manager, etc.

>One of the jobs will be to present at the end of the class, the group's solution and method used to arrive at the answers. The presentation must reflect the thinking of the group. You are most welcome to disagree, but you must be able to present the other member's argument.

>If there are any problems, first ask each member of the group to help solve the problem before you inquire outside your group.

>The participants will also be asked to reflect upon their experiences of working with a group. "While solving the open ended problem I am going to give you ,I want you to be continually assessing how it feels to work in a group. Some of the experiences will be positive, and some will be negative. While using the positive experiences to strengthen our students learning experiences, we need to work around your negative experiences and convert them positive experiences.

IMPLEMENTATION ~Several problems are attached in the Appendices. The participants will be given one of them.

3/ **A SPECIFIC SLIDE SHOW AND DISCUSSION ~**

60 - 90 minutes.

PURPOSE -Showing a series of slides demonstrating the constructivist mode of problem solving, the focus of this workshops so that the participants can question or bring their experiences into thediscussion. The slide show is to focus the participants on the task they have just completed and now relate it to children actually working in a class room.

IMPLEMENTATION -

MY SCRIPT : Now that you all have experienced working in a group , and have enjoyed a genuine problem, I want to share my Kindergarten class in New York with you. You are welcome to ask questions and clarify something you are seeing on a specific slide, or even ask your questions after the show." I will show them slides of children working cooperatively, solving problems , not necessarily typically mathematical [e.g. cooking and blocks] and ask the teachers to relate it to their own mathematical or problem solving experiences, or to children in their families and classrooms.

Slides of children solving problems and creating situations where they have to make choices.

Showing several different snack problems with children having to create their own algorithms by actually carrying out the function of preparing for and distributing snack.

Showing problem solving, and discussions occurring spontaneously and children helping and learning from each other.

OUTCOME - This is a time for teachers to air their doubts and concerns. With the concrete slides for them to see they will see that children are capable of very complex tasks.

4/- Discussion~ Will be ongoing through out the slide show. Once the show is

over I will throw the discussion open to the whole group. I will try to encourage questions arising from the group to be answerd by other participants.

5/- CLOSURE : I will, or a member of the workshop will make a list of points that arose during the discussion. This list will be left hanging at a prominent place so that participants can add on to it even when the second session is over. The points that I will definately raise is ~

>Working within a group enhances learning, and one always learns from peers.

>Discussion amoung collegues is the best way to tease out the tangles of implimenting any curriculum. The more diverse the input the stronger the learning will be.

Total time : 4 hours.

32

The participants have been exposed to constructing their own experiences by working on an open ended problem and as well as functioning as a group.

WORKSHOP

SESSION # 3 :

CREATING AN OPEN ENDED / GENUINE PROBLEM OF THEIR OWN :

DAY : 3

SESSION # 3 : CREATING AN OPEN ENDED /GENUINE PROBLEM OF THEIR OWN

The particpants will be divided into groups according to the classes and subjects they teach.

PURPOSE ~To give the participants confidence in them selves that games and problems can be created. The participants will work in groups.

INTRODUCTION -

10 minutes

MY SCRIPT - " When a child feels that they have to produce a correct answer, then the child looks to the teacher for assurance. When the child looks to the teacher for assurance, the child no longer has the courage to take risks and become a problem solver.

Some one who always looks to authority for support finds it difficult to make choices. Democracy is about choices, but it is not anarchy. There are rules that guide the class room. What rules do you think your class would need to have to function democratically ?

1/- **RECAPITULATION OF PREVIOUS WORKSHOPS** -

20 minutes.

Each group will be asked to reflect on sessions 1 and 2. Working together they can list a set of procedures that they would have to implement to have children working together to solve open ended problems.

2/- **CHARTING THEIR OWN EXPERIENCES** -

15 minutes

They will then be asked to chart their new learning, write them down on a sheet which will be put up as a wall newspaper for the other groups to share.

BREAK .

3/- **CREATING A GENUINE PROBLEM ~**

1 hour

The participants now will be encouraged to work in groups or pairs and make problems of their own. They should set certain objectives

> For the children as solvers of the problem [exploration, patterns, algorithms, classification, comparison etc] and

> for themselves as teachers [assessment of a child's level of understanding, exposing the children to new strategies or concepts]

4/- **PRESENTATION AND DISCUSSION ~**

30 minutes

Each group will now share what they have created with the other members of the workshop. Time permitting, and depending on the number of problems, the group can exchange problems, solve them and critique them.

OUTCOMES - Teachers get to gain confidence in themselves to create problems.

BREAK.

5/- A TIME FOR QUESTIONS, REFLECTION AND EVALUATION ~

1 hour

The forum will now be thrown open to the participants to clarify their difficulties. If there are no questions, [a workshop coordinators nightmare] then I will have to throw some in to the arena.

Anticipated questions	Notes to my self.
Do we not know how to make choices ?	You are part of the educated elite, as are the children you teach. My first interview with Harriet. Many Indians studying abroad experience the same sense of floundering when they first arrive, while many flower with the lifting if absolutes.
How do we assess children	Math. journals. Teacher assessment of learning style and child's place on the developmental continuum
Class organization	pattern station. Early morning problem for groups to solve. Gradual introduction, for your to feel your way and children to learn expectations.
Discipline	working together requires a solid foundation of experience and structure.
numbers	working in groups ensure individual attention.

Teacher attitude towards change. Who to look to for help. Where do we get new ideas ?	Question yourself. Most often the ideas will come to you. Talk to your colleagues. Teachers becoming too dependent on texts to have the autonomy to create their own curriculum. In America your promotions are based on college credits. There is a huge industry that supplies material and research to teachers.
cost of manipulatives	use waste material. You have to create your lessons.
What do you have against worksheets ?	Worksheets are closed ended. They look towards a single correct answer. If you can create worksheets that are open ended and require some of a child's initiative then you can use them to develop autonomy.
If American education is so superior why do we hear cases of Americans who leave school without knowing how to read?	The progressive movement has swung up and down on a pendulum. Not all American school have an enlightened education system. Like every where there are good schools and bad. What America has as a huge asset is a vibrant research in education and child development. And the fact that their public schools are run on house tax, so the people of a particular school district have a genuine stake in their children's education and take a very active part in determining school policy. Their public schools are not run for profit.

Lunch break.

EVALUATIONS:

10 + 30 minutes

Participants will be asked to use this time to also write out their evaluation of the workshop [Handout # 6].

A recapitulation of their experiences . If we have been having common groups working together through out the workshop, and the participants know each others style of functioning, then, we can redivide the groups so that they are now mixed. The participants in their new groups will be encouraged to think of their own topics for recapitulating the workshops, however I have also prepared a list in case of emergency.

TOPICS : >Open ended problem solving.

>Teacher attitude and expectation for encouraging problem solving.

> Classroom structure to enhance open ended problem solving.

> Working in groups.

> Where do we go from here ?

> Reactions to an American Kindergarten.

The group members can nominate a member of their group to read their assessment of the topic as a conclusion and recapitulation of the workshop. After each reading the floor will be thrown open to anybody else who wishes to comment.

6/- CLOSURE : SUMMING UP AND CONCLUSION ~

10 minutes

After listening to what the participants had experienced, I will briefly pull together my experiences of the workshop. Then I will conclude.

" To be truly educated we need to be free. Freedom means to be free from the influences of others, and free to make ones own choice. To be free we need to be autonomous individuals. Autonomy is not egocentricity. Freedom also means allowing others the same freedom we would expect for our selves. An autonomous citizen is a responsible citizens who will contribute to ,not be swayed by our society.

Where should the educational policy of our country aim ? Our history speaks of an education by rote and of undisputed absolutes. Our way was always determined by an authority. The masses, [that's almost all of us] were never given a choice. Ours is a new era of openness, technology and scientific discoveries. The Bureaucrats and Technocrats seem to have got a hold of the direction our country is heading. And we teachers under paid and unrecognized, in our lonely classrooms seem so powerless to shape this vast nation. But that is our greatest strength. We belong to no one but ourselves. We are truly free. And our power lies in the fact that from 5 - 25 years, however long our children get the opportunity to study, they are ours, not to mold, but to empower and educate. What we need is a cause and a voice. Our voices are not the giant roar of politicians but the daily murmur of activists. Let us take pride in ourselves, we have something to teach beyond the text books. The way we teach , the methods we employ is our message. We each have a value system . We must use it as our personal curriculum. We need to find a cause that spans everything and encompasses every one. I have chosen freedom and democracy. We are the largest and youngest democracy, but we are an ancient people burdened by our fragmented and suppressive past. We need to free ourselves and progressive education is one of the vehicles with which we can."

PART VII:

APPENDICIES

33
HAND OUTS

Whenever I have attended a workshop that has been particularly intensive or significant, I have felt the need to have some thing concrete to return to, to evoke memories and to refer to.

The handouts will have two functions: One is to help the participants focus on what to expect and what they are discussing during the workshops.
The other is a summary of some important facts that I want to bring to the notice of the participants.

HAND OUT 1 ~ An informal letter from me to the participants stating the aims and content of the workshop.

HANDOUT 2 ~ A programme of the three workshops and the content of each.

HANDOUT 3 ~ A comparison between traditional and constructivist education.

HANDOUT 4 ~ A set of problem sums.

HANDOUT 5 ~ Working of the right and left hemispheres of the brain.

HANDOUT 6 ~ Feedback from the participants. To be done during session three.

Dear Colleagues,

Being a teacher myself, I can vouch for the fact that there is a great thirst for knowledge among us elementary school teachers. However I can already hear your objections to my presentations, our large classes, traditional desk and chair settings, the pressure of a set syllabus, the weight of tests, exams and end of term assessments, the standardization of expectations and most of all the resource crunch that most of our schools face.

My aims are therefore very modest. I can never dream of sweeping changes, but I know other individuals have and can make a difference. I will aim to influence the just the one resource that is boundless and free, teacher attitude and effort. ***You*** *have the power to bring about these changes.* Now it is just up to me to be able to convince you!

Not only do I hope to be able to affect your aims toward your students, I hope to introduce a social context to learning. In these workshops I wish for you to experience, enjoy and therefore feel motivated to implement the power of

~ Genuine problem solving.

~ Working in a group, and relying on ones peers and not merely on the instructor.

~ To understand that the process of arriving at an answer is as powerful and fruitful whether the answer is correct or not.

~ That hands on problem solving and being able to think about the process used to solve it, and present the solution only enhances ones understanding of the problem, and therefore of math.

~ That the skills a constructivist classroom enhances are the skills the children will use later in life.

To fruitful beginnings!

Preminda Langer.

DATE:

Current address and phone number.

HANDOUT # 2.
ABOLISHING ABSOLUTES : A QUEST FOR OPENENDEDNESS. BRINGING CONSTRUCTIVIST MATHES TO THE EARLY CHILDHOOD CLASSROOM.

WORK SHOP SESSION # 1 ~

1/- Introduction and Welcome.

2/- Outline on the purpose of the workshop, and establishing a rational for the workshop.

3/- Two whole group task : I- A reflection of ones early experience with Math as a student and later as a teacher. ii- An analysis of employment.

4/- What is a constructivist math classroom ?

5/- Slide show - A constructivist Kindergarten Math classroom in America.

5/- Discussion.

6/- Closure.

WORKSHOP SESSION # 2 ~

1/- Group process ~ solving an open ended *genuine* math problem.

2/- Analysis of working on the problems and group dynamics.

3/- Slide show - Problem solving in a Kindergarten classroom.

4/- Discussion

5/- Closure.

WORKSHOP SESSION # 3 ~

1/- Recapitulation of workshops 1 and 2.

2/- What are the learnings from the two former workshops. Charting new learnings.

3/- Group process : Creating a curriculum piece. Creating open ended problems.

4/- Presenting and discussion of the problems.

5/- Reflection on the three sessions experience and future implications.

6 /- Closure.

HAND OUT # 3 - A COMPARISON.

Task	Traditional education	Constructivist education
Method of working .	Text books and work sheets . Present 2 dimensional pictures, or examples, followed by abstract symbolic representations. The children memorize and regurgitate their responses.	Actively manipulate concrete objects. Relationships are discovered and become firm concepts for wider action later on.
Aim	To practice and perfect solving algorithms. The working can be dome mechanically, checking answers at the back of the book. There is one way and one answer.	Children need: > to be autonomous and self motivated in their mathematical ability . > to discuss, reflect and make sense of the mathematical tasks and therefore procedures. >to feel responsible for making sense and communicating their mathematical reasoning, as opposed to merely completing a mathematical assignment. [Clements and Battista1990].
How	Learning is done alone, usually with paper pencil and perhaps a calculator. The work is mainly oral or written.	Learning takes place in a material and social environment. Children work in groups. Work is manipulative, oral & written.
Problem solving.	Once the algorithms have been mastered, the students are given word problems as a form of mastering the skill taught.	Problems are given first, they are open ended with several methods to get to the answer. Children solve these concrete problem and discover the computation skills for them selves.
Assess ments	The teacher role is to make the text book and prescribed syllabus as palatable as possible. A few students may be asked to discuss and demonstrate the computations on the board. The teacher then corrects the work/ papers. There is no immediate feed-back as corrections take time, and children may not be able to correct their errors in understanding the problem or clarify difficulties immediately.	> Is nor merely an asker or answerer of questions, but a partner in the learning process. Every student is also a teacher and learner in this shared process. >The adult's task is to constantly assess the children, not for the right answer, but their method of working, their developmental level and depth of understanding. >To provide them with appropriate tasks and materials with which children can construct, revise and find meaning through their own experience.

PROBLEM SUMS

THE GARDEN PROBLEM :

Kiran, Ravinder and Nadia were working together to make a garden larger.

Ravinder said , "We have to buy more fencing. If we increase the area of the garden, we will need more fencing to go around."

Kiran had a different opinion, " That's not true," she said, "We can use the same amount of fencing. We just have to move it to make the area of the garden larger."

Nadia disagreed with both Ravinder and Kiran. "I know a way we make the garden larger and use less fencing."

Who do you think is right ? Nadia, Kiran, Ravinder, all of them or some of them? Explain your reasoning after you have discussed this in your group. Have a group scribe write your group statement. Include sketches of your answers and use materials to prove your findings.

PROBLEM SUM

THE AQUARIUM :

Imagine that your school principal asks you to do a special job and gives you these written directions :

Your class will be getting a 30 gallon aquarium tank. The class will have Rs. 25.00 to spend on fish. You will plan which fish to buy. Use the **Choosing Fish for Your Aquarium Brochure** [see next page] to help you choose the fish. The brochure tells you things you must know about the size of the fish, how much they cost and their special needs.

Chooses many different kinds of fish as you can. Then write a letter to me explaining which fish you choose. In your letter,

1/- Tell me how many of each kind of fish to buy.

2/- Give the reasons you chose those fish.

3/- Show that you are no over spending and

4/- The fish will not be too crowded in the aquarium.

Choosing Fish for Your Aquarium

Planing ahead

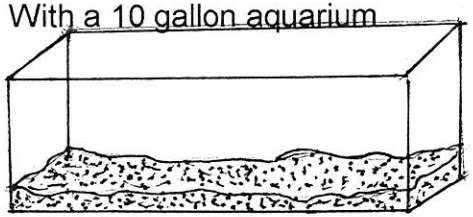
Use the information in this brochure to help you choose fish that will be happy and healthy in your aquarium. To choose your fish, you must know about the size of your fish, their cost, and their special needs.

Size of fish

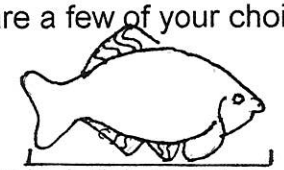
To be healthy, fish need enough room to swim and move around. A good rule is to have one inch of fish for each gallon of water in your aquarium. This means that in a 10 gallon aquarium the lengths of all your fish added up can be 10 inches at the most.

EXAMPLE :

With a 10 gallon aquarium

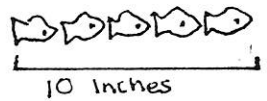


here are a few of your choices.



One 10 inch fish

a seven-inch long fish and a three-inch long fish or



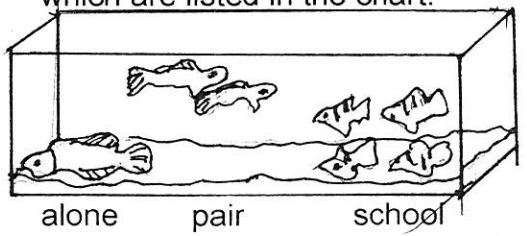
5 fish if each fish is only two inches long

Cost of the Fish

Some fish cost as little as one Rupee, others cost much more. The price of each kind of fish are listed in the chart.

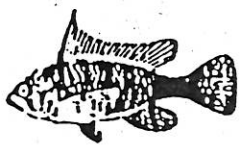
Special Needs

Use the chart to learn about the special needs of each kind of fish. Some fish need to live together in schools- a group of four or more of the same kind of fish. Other fish live in pairs or alone. A few kind of fish have other kinds of special needs, which are listed in the chart.



alone pair school

Chart for Freshwater Fish

Picture	Name	Cost	Length in Inches	Color	Special Needs, Facts
	Zebra Danio	$1	1 ½ inches	blue with gold lines	Lives in schools; gets along with other kinds of fish.
	Marbled Hatchetfish	$1	2 inches	yellow	Lives in schools; can leap 3-5 yards.
	Guppy	2 for $3	2 inches	red, blue and green	Lives in schools.
	Red-tailed Black Shark	$5	4 ½ inches	black with red tail	Fights with other sharks, but gets along with other kinds of fish.
	Cardinal Tetra	$5	1 ½ inches	red and green	Lives in schools.
	Blind Cave Fish	$2	3 inches	silvery rose	Lives in schools; uses its sense of smell and vibration to find food.
	Ramirez' Dwarf Cichlid	$5	2 inches	rainbow	Lives in pairs; rarely lives longer than 2 ½ years; gets along with other fish.
	Velvet Cichlid	$5	12 inches	olive with stripes	Can be trained to take food from the hand and can be petted. Must be kept only with other cichlids

THE WORKING OF THE BRAIN, AND ITS CURRICULAR IMPLICATIONS.

Patricia Davidson began researching the neurological implications of learning math in 1967 . She found that the left and right sides of the brain, each favored a different style of learning mathes.

Math style of a right hemisphere person ~ [Davidson's 'style II'].	**Math style of a left hemisphere person ~** [Davidson's 'style I']
>Good at counting backwards.	>Better at counting forward.
>Understands subtraction and division.	>Understands addition and multiplication.
>Does not enjoy step-by- step approaches to math and makes mistakes.	>Prefers a recipe approach, a step-by-step sequence.
>Good at estimating.	>Seldom estimates.
>May spontaneously give a correct answer without knowing why.	>Remember parts not wholes.
>Recognizes large scale patterns.	>Need to talk themselves through procedures.
>Enjoys geometric and three dimensional configurations.	>Precise in their working.
>May actually have a better understanding of math problems, but are impatient and imprecise.	>Do not have a logical assessment of their work. Are more interested in *how* than *why*

In a word a child who works favoring the left side of their brain will use mathematical formulas, but without really needing to know why they are doing so. This ability is greatly appreciated by the traditional system of education. Paper and pencil mathematics leaves the right hemisphere of the brain relatively untouched.

Davidson believes that tactile and spatial experiences a child can get from math manipulatives and materials such as blocks, clay, music rhythm and art, are critical for the development of the brain's right hemisphere. As noted earlier, by the age of ten unused synapses close down . This is also the time when the corpus callosum, a bundle of nerve tissues that connect the two hemispheres develops and integrates their operations. Now for the first time a child will be able to use both hemisphere to perform a task. This however will not have much benefits if both the hemispheres are not independently developed.

Source : [Loviglio on Davidson - Massachusetts Teacher 1981]

....and now some input from you.

This workshop covered _____ .

I have several presentations and workshops that I can do with your school.

> Abolishing absolutes, a problem solving approach to Math.

> The social context of learning.

> Classification , finding and analyzing patterns.

> Math games.

> Predicting and estimating.

> Presenting the process through journals, manipulatives, graphs, pictures or stories.

> Tasks that involve and foster conservation.

> Geometry and measurement.

> Graphing.

> Manipulatives.

> Scaffolding a teacher's role as partner and facilitator.

> Equity and expectation : Mathematics and Gender.

All these workshops involve working and exploring in groups. Please tick off other workshops you would be interested in doing and hand them to me at the end of the workshops.
At the back of this paper please write out your comments, questions and suggestions so that I can make the workshops as interesting and smooth as possible. Your name and address are welcome but optional.
With thanks,

Preminda Langer.

---------- tear off----------

If you have any problems, or wish to clarify certain doubts please feel free to contact me at

My current address.

_____ back page _____

☺ **a s s e s s m e n t** 😐 **a n d** ☹ **e v a l u a t i o n** ☺

Please feel free to write what you feel about these workshops. You may use as much paper as you need. I would however, like us *both* to know :

> What you are taking with you from these sessions.

> What you will implement in you classrooms.

GOOD LUCK !

34

MATERIALS FOR SUBSEQUENT WORKSHOPS

Scaffolding: A teacher's Role as Partner and Facilitator in a Constructivist Classroom.

Equity and Expectation: Mathematics and Gender.

SCAFFOLDING ~ A TEACHER'S ROLE IN A CONSTRUCTIVIST CLASSROOM.

In Vygotsky's theory, children's problem solving improves when working with an 'expert'. The role of the expert was not so much to provide the answers but *scaffold* a child's learning. This touches upon not what the child has mastered, but upon tasks that are in the process of development. The child stretches to understand the perspective of another and is therefore drawn into a different and broader approach to the situation.

How does one achieve support and yet enhance the child's initiative and autonomy?

>First the emotional tone needs to be warm, supportive and non judgmental.

>The adult's goals need to be clear - scaffolding and enhancing the child's development and learning, not guiding the child to a 'correct response'.

> Scaffolding could be described as a dance between the child and adult with the child leading and the adult following, giving clues where needed.

>An excellent example of scaffolding is the breaking down of tasks or ' chunking', so that each 'morsel' is commensurate with the child's momentary competence.

> Teachers can constantly readjust the amount of adult intervention to the child's growing competence, till the child can function independently. The adult should only intervene when the

child is truly stuck.

>In schools I have heard about and have visited several classes have the rule that a child in doubt has to ask three classmates for help before coming to the teacher.

>In actual mathematical reasoning, where the teacher takes the backseat.

>In the structuring of the class procedure *the teacher ensures* that the children work collaboratively, engage in dialogue, think about and justify how they are solving the problems [meta-mathematical thinking!], come to a consensus, feel free to make mistakes, and learn how to use their mistakes to further their learning. In short the teacher provides a social environment that is conducive to learning.

A Vygotsky-based mathematics construction of mathematical knowledge is not an adult-imposed system or a private problem solving activity, but a community endeavor of teachers and children together.
From - Scaffolding Children's Learning: Vygotsky and Early Childhood Education.

By - L.E.Berk and A. Winsler.

Published by National Association for the education of young Children.Washington D.C., USA.

IDEAS FOR A FUTURE WORKSHOP ON EQUITY : CAN TEACHER EXPECTATION DECREASE THE GENDER GAP ?

I begin this paper on gender equity from the Genesis of the two mythologies I know. I need not elaborate how powerful these myths have been in shaping the psyche of the people who are exposed to them. Eve was molded out of Adam's rib,[one I suppose he really didn't need too urgently !] and lead us all for ever into knowledge and original sin.

In Hindu mythology too, creation starts with *Purusha* - the male, or Lord Brahma, the lord of creation. Brahma divided his body into 2 parts - the male and the female. Then he implants Viraj [a male] into the female half to create Manu - a male and a very complicated mythological character, who then creates the world . The code of law that Manu [Who in actual practice could have been a term for several generations of law givers clubbed together] propounded was very detrimental to women. Women were chattel and possessions of their father's, husbands or sons. A woman without a man in her life was of no use to society and could be done away with.

In a class room there are several 'masculine subjects' -math, science and sports, and several feminine subjects - language arts, fine arts and crafts. While girls seem to develop their language skills faster, by high school there is a great evening out among the two sexes. However there is not this evening out in the area of sports, math and science.

Loviglio[1981] begins her paper on mathes with " Pity the poor high school math teacher confronting classes where ...otherwise bright students already 'know' they are incapable of learning what the teacher is fruitlessly about to teach them....it is unusual for an adult [to assert] "I could never do English [language]" or "I don't understand social studies" . Yet this fear of math is very real for many students. Unfortunately the segment of female students who feel they are incapable of doing math is disproportionately high.

☯ FEMALES AND MATH. ☯

" Men are not free to avoid Math: women are." is how Sheila Tobias begins her chapter on *Mathematics and Sex*, in her book *Overcoming Maths Anxiety* [1978]. The reason that it hit me like a sledge hammer because just the night before my 7th grader , struggling over her math home work muttered, " I'm going to be an artist, I don't need math anyway!"

As I read Tobias and Fennema's book [1978] several factors struck me as significant.
Research in both books affirm that there is a difference in math performance between males and females. Is this evidence of a difference in ability or attitude ? And more significant is this difference innate or learned ?

Lynn Osen in her study on German teanage girls [Tobias,1978] writes about the 'feminine math-tique' . A young woman may consider math and math related fields 'inimical to femininity'. These findings are also found in American middle school female students. Interestingly in the [former] Soviet Union , Nancy Dodge writes "[People]...are so accustomed to women's participating in all fields of study, that the performance of girls in math is comparable to that of boys in mathematics and physics."[Tobias,1978]. This a clear case of potentially capable women *not* being faced with what Fennema terms- *math avoidance* [Tobias,1978] . What are the reasons for this avoidance among the rest of the female populations around the

globe ?

As women have begun to aspire towards positions in the work force previously only open to men, there has been a growing interest in research in the area of mathematics and gender. It is very difficult to quantify differences or even to agree on the terms to be quantified while researching mathematic learning in people.

However certain generalizations have been accepted . Children may be born alike with certain math abilities but particular sex differences emerge and remain through out adulthood. [Tobias,1978]

☯ Girls compute better than boys in elementary school. This can be attributed to the fact that in elementary school girls mature biologically at an average 2 years faster than boys.

☯ Boys solve word problems better than girls [from age 13+] In separate studies conducted by Eleanor Maccoby [1964] and Susan Auslander [1978] females place more value on outside opinions of success in mathematics than males. So they may not be as willing to tasks risks or to think for themselves, two qualities necessary for effective problem solving.

☯ Boys take on more math than girls [from age 16 +]. John Ernest conducted a study *Mathematics and Sex* ,published in the American Math Monthly [1975]. The result of the study was that both girls and boys had trouble with math, both sexes did not enjoy the subject very much, but boys were motivated to stick with it because they felt it would further their careers, and also the boys had more confidence in their ability to learn it [Tobias,1978].

☯ Girls learn to hate math sooner than boys and possibly for different reasons.

☯ As math begin to get harder, girls have less motivation to continue to strive, struggle and perform well.

☯ By aged 10 both sexes are encouraged not to excel in areas 'designated' by society as outside their sex role.

☯ Is mathematical competence related to hormonal levels ? Studies have

indicated that with the onset of puberty, girls begin to also coincidentally lose interest in math. However it has been proven that what happens within the female body has nothing to do with mathematical ability. It is the self image and the pressures of society that give girls the self image and lack of confidence as mathematicians.

What gives girls this negative self image ?

- Parents, peers and teacher's seem to forgive a girl when she does badly in math, but come down heavier when she doesn't do well in language arts.
- Girls [and their parents] ,fear she will be thought of as odd or different if she excels in math. I recall my first cousin left advance mathematics in high school because she was the only girl in her class. Also many female students felt that they would have to work harder to attain the same level of competence and recognition as boys [Fennema, 1990], and so get discouraged.
- In mathematics texts the examples are either male oriented or demeaning of females.
- Of the female mathematicians who have been successful today, despite this being thought of as a 'masculine' success' ,enjoy some real tangible advantages'.[Tobias, 1978]. Among them was strong family support.
- In the concluding paper *Gender Differences in Mathematics :A Synthesis,* Leder and Fennema [1990] seem to take a piece out of John Dewey's *Experience and Education*. "Students face and interpret actions, events and opinions around them.....It has become apparent that student's perceptions of the experience they have may detract from potential educational treatment and opportunities to learn." The extent that teachers contribute to this..... "had far reaching consequences on how the two genders learned mathematics. Teachers seemed, in many class rooms to interact with boys more and praise them easier than their female students. This was found to be true in widely divergent classrooms in different countries.. Interestingly Fennema notice 7 grade teachers took greater pains, felt more responsible and took 3 times as long with the lowest achieving male

students. There is also indication that male students are more often selected for remedial mathes teaching than females with the same learning levels.

☯ Casserly's article in *Mathematics and Gender* [1975] reported that teachers would become emotionally upset if female students could not solve a mathematical problem. To 'prevent' the girls from getting discouraged they would give them the solution. This had three implications:

1/~The girls were not being allowed to have a successful problem solving experience.

2/~The girls need to learn to deal with the negative stress of problem solving and find their own strategies for over coming it.

[This is one of those lessons-for-life that I believe mathes can teach all of us. Life is not a bed of roses. Its hard work !-P.]

3/~The girls themselves reported that they got the message that *the teachers felt* problem solving in mathes was not important or useful for them.

☯ In Leder's article on *Gender Differences in Mathes* [Fennema, 1975] she writes females attribute success to effort, while males attribute success to ability. As regarding failure males relate it to effort while females attribute it to ability.

☯There is evidence [Fennema,1975] that classes organized to provide competition result in some what better learning for boys and classes that encourage cooperation are better for girls.

☯ In their three-year study of British classrooms Walden and Walkerdine [1985] [Fenemma,1975] wrote about their work with the SMILE {Secondary Mathematics Individualized Learning Experiment}.The girls liked SMILE. It was safe, cooperative and predictable. The boys on the other hand disliked it. They wanted to leave the practices of the elementary school behind. Teachers also encouraged girls to take the less demanding school based Certificate of Secondary Education examination than the more demanding General Certificate Education Ordinary level. Their study showed that the teacher's beliefs [and hence the beliefs of wider society] have shaped prevalent school practices and policies. These beliefs in a nut shell are - 'female students are more dependent on confirmation by others and

are less capable of risk taking, independent work and handling complex mathematics. Implied, too, is the extent to which the students themselves have accepted and internalized these expectations and beliefs."

This list could go on endlessly. To summarize we can say it is societal expectations, especially teacher expectation that give girls their self image and confidence in math. Where gender stereotypes have broken down, particularly out of economic necessity [Pioneer woman, Black families, India's Freedom Struggle, the Communist blocks,{and to a point} the World Wars] women have been freed to participate more fully in the building of their society. When society returns to *normal* then the status quo returns. We need to build an autonomous self image that can help girls and therefore women maintain their productive [as opposed to merely reproductive] place in society. How do we bring about this equity ? Not by treating the genders equally but by acknowledging the differences and treating them equitably.

☯ DIFFERENT BUT EQUAL ☯

Like all species on earth, biology gave our species one dominant role on earth - to survive and to reproduce. In both cases the role of the two genders have been well defined. The males hunted, the females gathered. The males roamed, the females stayed. The females reproduced and the males fought hard to see that the gene pool that survived was their own. Strength and power were physical and then economic. Jung spoke of a social subconscious. A million years of fossils and 7,000 years of recorded history have given women their story, their role and their mind set.

Can we counter biology and a million years of evolution ? I believe we can.
☯ From the constructivists point of view the pre-operational children, bound by concrete perceptual cues, relies on observable physical evidence to form their identity. What they see is what they know. It is this more than biological or social

influences that gives the child gender identity. [Ullian, 1985].

☯ How does the brain function ? Lorraine Loviglio [1981] fascinating article on the functioning of the brain and mathematical ability has some pertinent insights. The left hemisphere processes information in a sequential , linear and analytical manner and plays a primary role in such activities as reading, writing and computation. The right hemisphere tends to specialize in a nonverbal, simultaneous and holistic approach. It is the hemisphere required for making sensory discriminations. Particia Davidson and Marolda believe that mathphobic girls [I would prefer to say children] could be helped by teachers taking a less strictly computational approach in early grades. At the age of 5-6 the left hemisphere in girls is usually more developed than their right hemisphere. In boys it is the opposite. These girls usually reach the first grade better equipped to write neatly, read well and add and subtract correctly. This orderly sequential learning is strongly encouraged and re-enforced by teachers. However by allowing girls to skip the manipulation of physical and spatial materials the schools set the stage for the 'eventual down fall' of female mathematicians. This starts as early as fourth grade. Schools have to *build into their mathes programmes more spatial reasoning to stimulate girl's right* hemispheres. Davidson and Marolda [1981]have developed a series of teaching techniques that allows the same lessons to be taught in two different ways. What are these materials that can have such a profound impact ? Besides mathes manipulatives Davidson recommends clay, blocks, rhythm and art.

Why must we concentrate on early childhood to develop the two hemispheres ? Till the age of ten the brain functions as two independent hemispheres. It is in this decade that we have the opportunity to develop them . At approximately the age of ten the corpus callosum develops. This is a bundle of nerve tissue that connects the two hemispheres. Now the child can call upon both hemisphere to function simultaneously but it is not going to be beneficial if one of the hemispheres is underdeveloped.

We see now that neither biology nor gender role identity are immutable. Can we teachers do something concrete to bring about a permanent change in the way children view mathes. Again I believe we can.

☯ STRATEGIES FOR CHANGE ☯

☯ If we can follow Davidson's recommendations of fully developing the children's brains then both girls and boys will benefit. To me this is perhaps the most important strategy.

☯ Seeking unconventional role models is another important strategy. It will widen the children's worlds and liberate their dreams.

☯ Fennema & Peterson [1985,1987] suggest several classroom strategies to decrease gender related differences.

"1/- Placing more stress on cooperative learning instead of competitive ones.

2/- However teacher's should not tacitly accept socialization by girls during group work mathes classes. [The message being this is business not a social call].

3/- Teachers need to ensure that *all* students attend fully to mathematical tasks.

4/- Teachers need to increase their interaction with females on high-cognitive-level mathematic activities.

5/- They must expect females to figure out mathematical answers and then praise them for doing so. [Not a very autonomous method! - P.L.]

6/- When the girls respond incorrectly the teachers need to encourage divergent and independent thinking by giving them hints on alternative strategies rather than telling the answers.

7/- Perhaps the most important thing that a teacher can do is to expect female students to work independently and encourage then to engage in independent learning behavior."

When Fennema and Peterson talk about 'praising them for participation and performing well on high cognitive level tasks' it brings to my mind my 7th grade mathes teacher. She marked us for *method.* That is to say our very effort to seek the correct answer was rewarded. The specter of getting a naught vanished with

her enlightened approach. It was the safest math classroom I ever had and a method I followed in my own.

☯ Meyer and Koehler [Fennema, Chapter 4] state that autonomous learning behavior, the ability to work independently at high-level cognitive-activities does not develop when one becomes an adult ;instead they are learned over the years as children are allowed, forced or expected to exhibit them.
☯ In other words children have to be allowed to construct their own knowledge of mathematics. This will be encouraged by the building up of an inner belief system and a perception of the usefulness of mathematics
☯ Begle [1979] , Good, Grouz and Ebmeir [1983][Fennema,1990] found that text books and classroom activities that emphasized reasoning and understanding of mathematical ideas resulted in children performing at higher levels on tests that measure concepts.

There are several more concrete strategies for increasing Mathematical abilities in female students. The one that struck me as unusual, but very doable was a study on 58 Harvard students [Fennema,1990]. The women did worse than the men on a test that measured their spatial skills. Then students of both sexes spent 5 hours each playing *Targ* and *Battle Zone* [two shoot out video games]. Afterwards everyone took another spatial skill test. The men's scores did not change significantly : neither did the women in the control group. However the scores of the women who played the video games improved dramatically. They scored as well as the men. [Gameswomanship 1984, New York Times Science Magazine]. Ah ! That life could be so effective and so simple !

Yes there is hope. As long as there can be change we can move forward. What I fear however with the liberation of women will come the masculinization of the female. I have seen the competitive edge of my husbands females collegues.Their petty jealousies and rapacious ambitions have quenched any nurturing or

cooperative spirit. If we are going to empower our girls we not only have to liberate our boys from their masculine burdens but we need to change the whole world order ! [A tall order !]. Female economic independence will mean less dependency on men to satisfy female needs. The less we need each other the more equal our partnership can be. How do we achieve this destination of economic independence ? Our education is one of the directions and mathematics is one of the routes.

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PART VIII:

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